9 – 13 June 2024
Portorož | Slovenia

embec 2024

9th European Medical and Biological Engineering Conference

BOOK OF ABSTRACTS

IFMBE
European Alliance for EAMBES Medical and Biological Engineering & Science
SLOVENIAN SOCIETY FOR MEDICAL AND BIOLOGICAL ENGINEERING
Faculty of Electrical Engineering, Tržaška 25, 1000 Ljubljana, Slovenia
tel.: +386 1 4768 783, homepage: www.dmbts.si, e-mail: info@dmbts.si
FE UNIVERSITY OF LJUBLJANA Faculty of Electrical Engineering

9^{th} European Medical and Biological Engineering Conference

Portorož, Slovenia
9–13 June, 2024

Book of Abstracts

Organised by:
IFMBE – International Federation for Medical and Biological Engineering,
EAMBES – European Alliance for Medical and Biological Engineering & Science,
DMBTS – Društvo za biomedicinsko tehniko Slovenije,
and University of Ljubljana

Edited by:
Tomaž Jarm, Rok Šmerc,
and Samo Mahnič-Kalamiza

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani

COBISS.SI-ID 198471939

ISBN 978-961-243-465-6 (PDF)

URL: https://www.embec2024.org/wp-content/uploads/2024/06/EMBEC2024_Book_of_Abstracts.pdf

Založnik: Založba FE, Ljubljana
Izdajatelj: Fakuleta za elektrotehniko, Ljubljana
Urednik: prof. dr. Sašo Tomažič
Kraj in leto izida: Ljubljana, 2024
1. elektronska izdaja

PROGRAMME

Plenary Lectures

Thursday morning Plenary, Thursday, Jun 13 2024, 8:30-10:00
Location: Lecture room A+B
Session: **Plenary talks session** **35**

Oral Presentations

Monday morning Track C, Monday, Jun 10 2024, 10:30-12:00
Location: Lecture room D
Session: **S02 - Advances in BME in the Asia Pacific Region** **44**
Chairs: James Goh and Ichiro Sakuma
Organisers/Conveners: James Goh, Ichiro Sakuma

Monday afternoon Track A, Monday, Jun 10 2024, 14:15-15:30
Location: Lecture room A+B
Session: **S07 - Electrochemical Effects in Bioelectrical Therapies** **47**
Chairs: Antoni Ivorra and Samo Mahnič-Kalamiza
Organisers/Conveners: Antoni Ivorra and Samo Mahnič-Kalamiza

Monday afternoon Track B, Monday, Jun 10 2024, 14:15-15:30
Location: Lecture room C
Session: **S26 - IFMBE Education in BME: Transformation of the BME Education in Asia Pacific Region** **49**
Chairs: Martha Zequera and James Goh
Organisers/Conveners: Martha Zequera Diaz and James Goh

Monday afternoon Track C, Monday, Jun 10 2024, 14:15-15:30
Location: Lecture room D
Session: **S03 - Applications of Entropy in Health Care** **52**
Chair: Alexander Martynenko
Organisers/Conveners: Alexander Martynenko

15:15 OR-032 **Detecting Heart Failure Relations: A Preliminary Study Integrating HRV, LVEF, and GLS in Patients with Ischemic Heart Disease and Dilated Cardiomyopathy** 53
Katerina Iscra, Laura Munaretto, Aleksandar Miladinovic, Jacopo Giulio Rizzi, Marco Merlo, Agostino Accardo, Milos Ajcevic

Monday late afternoon Track A, Monday, Jun 10 2024, 16:00-18:15
Location: Lecture room A+B
Session: **S08 - Electroporation meets cardiac treatment** **53**
Chairs: Lea Rems and Bojan Vrtovec
Organisers/Conveners: Lea Rems

16:00 OR-033 **What do we (think we) know about electroporation** 53
Damijan Miklavčič

16:15 OR-034 **Initial single centre experience with pulsed field ablation for treatment of cardiac arrhythmias** 54
Matevž Jan, Tine Prolič Kalinšek, Jernej Iršič, Damijan Miklavčič, Jernej Štublar

16:30 OR-035 **Numerical modelling in pulsed field ablation** 55
Bor Kos

16:45 OR-036 **Machine Learning Models for Predicting Electroporation-Dependent Tissue Properties and Temperature Distributions from Pulsed Electric Fields** 55
Edward Jacobs, Pedro Santos, Rafael Davalos

17:00 OR-037 **In Vivo Cardioporation Enhanced Myocardial Gene Delivery** 56
Richard Heller, Mark Jaroszeski, Carly Boye, Michael Francis, Jacob Hensley, Alex Otten, Sezgi Arpag-McIntosh, ***Anna Bulysheva***

17:30 OR-038 **Gene electrotransfer – the role of electrical and biological parameters in in vitro experiments** 56
Alenka Maček Lebar

17:45 OR-039 **Precision medicine approach to cell therapy in heart failure** 57
Bojan Vrtovec

18:00 OR-040 **The LVAD-CD34+ Stem Cell Combination Therapy in Non-ischemic Dilated Cardiomyopathy Patients** 57
Gregor Poglajen, Sabina Frljak, Gregor Zemljič, Andraž Cerar, Bojan Vrtovec

Monday late afternoon Track B, Monday, Jun 10 2024, 16:00-18:00
Location: Lecture room C
Session: **S12 - Intelligent Health Monitoring for Precision Medicine: A Global Perspective** **58**
Chairs: Li Li and Hairong Zheng
Organisers/Conveners: Li Li

16:00 OR-041 **Multimodal Biomedical Imaging for the Advance Precision Medicine: Past, Present and Future** 58
Hairong Zheng

16:15 OR-042 **United States Perspective on Intelligent Health Monitoring in Precision Medicine** 58
Shankar Krishnan

Monday late afternoon Track C, Monday, Jun 10 2024, 16:00-18:15
Location: Lecture room D
Session: **Biomedical instrumentation, signal processing and imaging** **61**
Chairs: Josias Wacker and Kazimierz Pęczalski

Tuesday morning Track A, Tuesday, Jun 11 2024, 10:30-12:15
Location: Lecture room A+B
Session: **S15 - Optimizing Healthcare: Patient-Centered Technology Innovations** **65**
Chairs: Paulo Carvalho, Fabiola Martinez-Licona and Murilo Conto
Organisers/Conveners: Paulo de Carvalho, Fabiola Martinez, and Murilo Conto

Tuesday morning Track B, Tuesday, Jun 11 2024, 10:30-12:00
Location: Lecture room C
Session: **Biomedical engineering in developing countries** **67**
Chairs: Ernesto Iadanza and Wanzi Su

Tuesday morning Track C, Tuesday, Jun 11 2024, 10:30-12:00
Location: Lecture room D
Session: **S17 - Regulatory Learning** **70**
Chairs: Laura Lopez-Perez and Beatriz Merino
Organisers/Conveners: Giuseppe Fico

Tuesday afternoon Track A, Tuesday, Jun 11 2024, 14:15-15:30
Location: Lecture room A+B
Session: **S08 - Electroporation meets cardiac treatment** **73**
Chairs: Lea Rems and Chiara Collesi
Organisers/Conveners: Lea Rems

Tuesday afternoon Track B, Tuesday, Jun 11 2024, 14:15-15:30
Location: Lecture room C
Session: **S27 - Perspectives of BME Education** **75**
Chairs: Ratko Magjarevic, Nicolas Pallikarakis and Martha Zequera
Organisers/Conveners: Ratko Magjarević, Nicolas Pallikarakis and Martha Zequera

Tuesday afternoon Track C, Tuesday, Jun 11 2024, 14:15-15:30
Location: Lecture room D
Session: **S16 - Out-of-the-lab dry EEG** **78**
Chairs: Jens Haueisen and Patrique Fiedler
Organisers/Conveners: Jens Haueisen and Patrique Fiedler

Tuesday late afternoon Track A, Tuesday, Jun 11 2024, 16:00-18:00
Location: Lecture room A+B
Session: **IFMBE Young Investigators Competition** **81**
Chairs: Helena Cindrič and Zhivko Bliznakov

Tuesday late afternoon Track C, Tuesday, Jun 11 2024, 16:00-18:00
Location: Lecture room D
Session: **S24 - Wireless Wearable Networks for Physical Function Rehabilitation Monitoring** **84**
Chairs: Željka Lučev Vasić, Ivana Culjak and Yueming Gao
Organisers/Conveners: Željka Lučev Vasić, Ivana Čuljak, and Yueming Gao

Wednesday morning Track A, Wednesday, Jun 12 2024, 10:30-12:00
Location: Lecture room A+B
Session: **S09 - Health Technology Assessment of Medical Devices - Advances and Challenges** **88**
Chairs: Murilo Conto and Ernesto Iadanza
Organisers/Conveners: Murilo Contó and Ernesto Iadanza

Wednesday morning Track B, Wednesday, Jun 12 2024, 10:30-12:00
Location: Lecture room C
Session: **S22 - Tools, technologies and computing for point-of-care person-centered health and care delivery** **90**
Chair: Eleni Kaldoudi
Organisers/Conveners: Eleni Kaldoudi

Wednesday morning Track C, Wednesday, Jun 12 2024, 10:30-12:00
Location: Lecture room D
Session: **S19 - IFMBE Industry Committee: Medical Technologies - From Concept to Commercialization** **94**
Chairs: Piotr Ładyżyński and Martha Zequera
Organisers/Conveners: Piotr Ladyzynski and Martha Zequera Diaz

Wednesday after lunch Track B, Wednesday, Jun 12 2024, 13:30-14:15
Location: Lecture room C
Session: **IFMBE Scientific Challenge** **97**
Chairs: Bor Kos and Paulo Carvalho
Info: Additional talks in this session:
13:30 Jorge Henriques "The challenge: past and future"
13:40 Bor Kos "This year's challenge topic"

13:30 OR-121 **A Machine Learning Approach for Predicting Electrophysiological Responses in Genetically Modified HEK Cells** 97
Jacopo Vitale, Martina Sassi, Leandro Pecchia

13:45 OR-122 **Optimizing Electroporation Responses in Genetically Engineered HEK Cells: An Ensemble Learning Approach** 97
Francesco Bassi, Simone Kresevic, Alessandro Biscontin, Aleksandar Miladinovic, Milos Ajcevic, Agostino Accardo

Wednesday after lunch Track C, Wednesday, Jun 12 2024, 13:30-14:15
Location: Lecture room D
Session: **Cellular and tissue engineering** **98**
Chairs: Adriana Lungu and Dongan Wang

13:30 OR-123 **Decellularized Tissue Engineering Hyaline Cartilage Graft for Articular Cartilage Repair and Its Forward-Looking Test for Space Medicine** 98
Dongan Wang

13:45 OR-124 **Multicomponent printing inks for the designing of 3D extracellular matrix-mimetic biomaterials** 98
Adriana Lungu, Raluca Dobrisan, Valentina Ciobanu, Minodora Marin, Sorina Dinescu, Izabela-Cristina Stancu

14:00 OR-125 **Artificial Bone Extracellular Matrices based on 3D-printed nanostructured hydrogels** 99
Adriana Lungu, Izabela-Cristina Stancu, Elena Olăreț, Filis Curti, Carmen-Valentina Nicolae, Sorina Dinescu, Alexandra-Elena Dobranici, Bogdan Stefan Vasile

Wednesday afternoon Track A, Wednesday, Jun 12 2024, 14:15-15:30
Location: Lecture room A+B
Session: **S20 - System design for biomagnetic applications using optically pumped magnetometers** **99**
Chairs: Tilmann H. Sander, Daniel Baumgarten and Urban Marhl
Organisers/Conveners: Tilmann Sander, Daniel Baumgarten, and Urban Marhl

14:15 OR-126 **Active compensation for OPM-MEG inside a two-layer magnetically shielded room** 99
Michal Władziński, Anna Jodko-Władzińska, Tilmann H. Sander

14:30 OR-127 **Quantitative magnetic nanoparticle imaging with magnetorelaxometry in unshielded environments** 100
Aaron Jaufenthaler, *Daniel Baumgarten*

14:45 OR-128 **Improved degaussing procedure for a magnetically shielded room** 100
Peter Koss, Jens Voigt, Allard Schnabel, Ronja Rasser

15:00 OR-129 **Full MEG system based on helium OPMs for medical imaging** 101
Rudy Romain, Jaroslaw Rutkowski, Sergey Mitryukovskiy, Kevin Arth, Matthieu Le Prado, Agustin Palacios-Laloy, Etienne Labyt

15:15 OR-130 **Full OPM-MEG system with limited sensor counts** 101
Urban Marhl, Rok Hren, Tilmann H. Sander, *Vojko Jazbinšek*

Wednesday afternoon Track B, Wednesday, Jun 12 2024, 14:15-15:30
Location: Lecture room C
Session: **S28 - BME Education in Europe** **102**
Chairs: Nicolas Pallikarakis and Ratko Magjarević
Organisers/Conveners: Ratko Magjarević and Nicolas Pallikarakis

Wednesday afternoon Track C, Wednesday, Jun 12 2024, 14:15-15:30
Location: Lecture room D
Session: **BME Miscellaneous topics** **104**
Chairs: Milica Nikolic and Nikolay Dukov

Wednesday late afternoon Track A, Wednesday, Jun 12 2024, 16:00-18:00
Location: Lecture room A+B
Session: **S14 - Non-invasive methods for monitoring electrophysiological and hemodynamic brain activity** **106**
Chairs: Vojko Jazbinšek, Tilmann H. Sander and Stanislaw Wojtkiewicz
Organisers/Conveners: Vojko Jazbinšek, Tillman Sander, and Stanislaw Wojtkiewicz

Wednesday late afternoon Track B, Wednesday, Jun 12 2024, 16:00-18:00
Location: Lecture room C
Session: **S25 - IFMBE Education in BME: BME Education in Latin America and BME in Africa** **110**
Chairs: Martha Zequera, Virginia Ballarin and Sudesh Sivarasu
Organisers/Conveners: Martha Zequera Diaz and Virginia Laura Ballarín

Wednesday late afternoon Track C, Wednesday, Jun 12 2024, 16:00-18:15
Location: Lecture room D
Session: **Artificial intelligence in healthcare** **115**
Chairs: Jacopo Vitale and Marilena Tarousi

Thursday morning Track B, Thursday, Jun 13 2024, 10:30-12:00
Location: Lecture room C
Session: **S11 – IFMBE Education in BME: Education in Biomedical Engineering for Students** **118**
Chairs: Martha Zequera, Ratko Magjarevic, Shankar Krishnan and Piotr Ładyżyński
Organisers/Conveners: Martha Zequera Diaz, Ratko Magjarevic and Shankar M. Krishnan

Thursday morning Track C, Thursday, Jun 13 2024, 10:30-12:00
Location: Lecture room D
Session: **Clinical engineering** **121**
Chairs: Alessio Luschi and Rok Hren

Poster Presentations

Page

Tuesday morning poster session, Tuesday, Jun 11 2024, 10:00-10:30
Location: Coffee break and poster display area
Session: **Poster session** **127**
Info: The same posters will be presented also during the afternoon coffee break, i.e. this Poster session will continue during the Tuesday afternoon coffee break.
Odd-numbered posters (PO-01, PO-03, ...) comprise the Tuesday poster session and presenters are expected to be present at their posters during the two coffee breaks.

Wednesday morning poster session, Wednesday, Jun 12 2024, 10:00-10:30
Location: Coffee break and poster display area
Session: **Poster session** **144**
Info: The same posters will be presented also during the afternoon coffee break, i.e. this Poster session will continue during the Wednesday afternoon coffee break.
Even-numbered posters (PO-02, PO-04, ...) comprise the Wednesday poster session and presenters are expected to be present at their posters during the two coffee breaks.

PLENARY LECTURES' ABSTRACTS

Plenary talks session

Monday morning Plenary
Jun 10, 9:15 – 10:00

PL–1

New ablation method based on irreversible electroporation – a game changer in cardiac ablation

Atul Verma
McGill University, Canada

Abstract was not received.

Plenary talks session

Monday afternoon Plenary
Jun 10, 13:30 – 14:15

PL–2

Cardiac regeneration: where we stand

Mauro Giacca
King's College London, United Kingdom

Abstract was not received.

Plenary talks session

Tuesday morning Plenary
Jun 11, 8:30 – 10:00

PL–3

Applications of Artificial Intelligence in Clinical Diagnosis, Therapy and Operations

Shankar Krishnan
Past-President, IFMBE, United States

There have always been continuous efforts to enhance the quality of healthcare. Recently, applications of Artificial Intelligence (AI) have demonstrated promising roles in transforming accurate, efficient, and accessible clinical diagnosis and treatment in addition to e improving hospital operations. The objective of this talk is to highlight major applications of AI in the healthcare domain in synchrony with the mission of biomedical engineers worldwide.

By analyzing vast amounts of patient health data including physiological, pathological, and imaging results, and genomic information, AI techniques have increased the overall diagnostic efficiency. Machine Learning (ML) algorithms can identify abnormalities and suspicious patterns that may be missed by clinicians. AI tools aid radiologists in interpreting complex fractures, and tumors from CT, MRI, PET-CT, and 3-D ultrasound scans. ML is applied for analyzing imaging data with biomarker results for early detection of malignancies reducing human errors and swift start of treating cancer patients.

Applications of AI and ML have been instrumental in effective and personalized therapy to patients based on a comprehensive analysis of historical and current data, genetic information, and responses to therapy in similar clusters. AI applications in robotic surgeries minimize invasiveness, improve precision, and reduce complications and recovery times. AI and ML-powered methods perform intelligent searches of chemical and biological databases, determine potential drugs, and predict their safety and efficacy precisely, thus reducing R&D and product launch costs.

AI and ML-based technologies support remote consultations, diagnosis, monitoring, and management of patients with constrained access to timely healthcare services. Applications of AI have resulted in the improvement of overall hospital operations including reduced readmissions, efficient staffing and scheduling, resource optimization with predictive analytics, cost reduction in equipment, maintenance and upgrades, and enhanced safety, and compliance.

Selected examples of AI applications leading to the improvement in diagnosis and therapy associated with cardiovascular, cancer, diabetes, and neurological diseases and hospital operations will be presented.

Impressive benefits can be realized by strategic applications of AI. However, consequent challenges in AI implementation related to transparency, data sharing, bias, confidentiality, privacy, and security of patient data and ethical and trust aspects will have to be alleviated. Regulatory agencies such as the FDA are approving AI-based medical devices but proceeding with caution.

In conclusion, the applications of technologies and processes based on AI and ML predict and promise multifaceted enhancements in the quality of clinical diagnosis, therapy, and operations resulting in better healthcare and positive impacts on patient care globally, blending with the mission of the BME community.

PL–4

Cybersecurity for connected medical devices

Dubravka Maljević
BG Kliniken, Germany

Abstract was not received.

Plenary talks session

Tuesday afternoon Plenary
Jun 11, 13:30 – 14:15

PL–5

The Joy of Point-Based Visualizations

Blaž Zupan
University of Ljubljana, Slovenia

Two-dimensional embeddings resulting from dimensionality reduction techniques such as t-SNE, UMAP, and multidimensional scaling are widely used in various scientific fields to visualize high-dimensional data in two-dimensional, point-based visualizations. In this talk, I will introduce some common projection and embedding techniques and show through various examples why I find them useful, or rather exciting, for analyzing tabular, textual, or image-based data. I will also discuss how AI and other computational techniques can help us explain the resulting visualizations.

Plenary talks session

Wednesday morning Plenary
Jun 12, 8:30 – 10:00

PL–6

History of irreversible electroporation and future clinical applications

Rafael V. Davalos
Georgia Tech, United States

Irreversible Electroporation (IRE) is a minimally invasive surgical therapy we invented to treat unresectable tumors using low-energy microsecond pulses. IRE is unique among tissue ablation techniques in its mechanism of only targeting the cell membrane while tissue molecules, everything encompassing collagen structures to proteins, remain intact; thereby making treatment near critical structures such as major blood vessels and nerves possible. We are developing an advanced form of the technology, high frequency irreversible electroporation (HFIRE), for the treatment of cardiac disease, cancer, and other malignancies. This new therapy preferentially targets cancer cells over healthy cells, promotes a positive immune response, and alleviates the need for a paralytic. Furthermore, with regards to cancer therapy, these pulses have been shown to increase antigen activity with the release of damage associated molecular pathways (DAMPs) and proteins. We have demonstrated that fine-tuning the pulsing parameters applied can influence biophysical effects as well as modulate therapeutic outcomes. By modifying the pulse parameters and field strength, the activation of specific modes of cell death mechanisms can allow for controlling the extent of an electroporation-mediated immune response. Other critical considerations include modifying burst number to balance electroporation saturation against escalating thermal effects, optimizing therapeutic outcomes. Our group is also developing Electro Antibacterial Therapy (EAT), an advanced electroporation-based technology which targets intratumoral bacteria in pancreatic cancer by boosting antibiotic uptake in malignant cells harboring cancer-promoting bacteria like Fusobacterium nucleatum. EAT demonstrates effectiveness at clearing out intracellular bacteria, even at the reversible regime, offering promising therapeutic advantages. Our preclinical work focuses on helping canine patients with spontaneous disease, which are excellent translational models for human disease. Results of our ongoing trials have been extremely positive, supporting that HFIRE is effective for the treatment of cancer, including tumors refractory to surgery, radio- and chemotherapies. This presentation will also discuss recent advances in pulsed electric field therapies to target various aspects of the tumor microenvironment and potential future clinical applications.

PL–7

Deep Brain Stimulation – Data Analysis for Clinical Support

Karin Wårdell[1], Teresa Nordin[1], Dorian Vogel[2], Simone Hemm[2]
[1]Linköping University, Sweden
[2]University of Applied Sciences and Arts Northwestern Switzerland, Switzerland

Deep brain stimulation (DBS) is an import-

ant therapy for movement disorders such as Parkinson's disease (PD), essential tremor, and dystonia. The clinical indications for DBS are continuously increasing and are expanding towards psychiatric illness. Following MRI and surgical planning of trajectory and target, a thin DBS lead is implanted in a deep brain structure using stereotactic neurosurgery. The choice of brain target is dependent on the patients' symptoms, for example the subthalamic nucleus is commonly used in PD. Over the last decade, several new DBS-lead designs and systems have reached the market. This includes voltage and current stimulation modes, and new configurations of the electrode contacts including split contacts for steering of the stimulation field. Other advances are battery life-length extension, support in postoperative programming, and DBS systems designed for adaptive stimulation i.e. combined recording of local field potentials (LFP) and stimulation in a closed-loop. All improvements generate more data and increase the demand of technical aids to summarize them and to go from the traditional clinician's "mental imagination" to "intuitive visualization" in the definition of target, implantation procedure, and follow-up to gain the best clinical outcome.
This presentation will give an overview of the DBS system and supportive techniques for surgical planning, implantation, and patient follow-up. The focus will be set on visualization and our method for electric field (EF) simulations for investigation of the stimulated tissue. Examples of patient-specific modeling and simulations using the finite element method (FEM, Comsol Multiphysics AB, Sweden) will be presented, and how these can be further explored for probabilistic group analysis to optimize the treatment with minimized side effects. Further development of the workflow allows for visualization of traced thin white matter fibers and outlined brain structures together with the patient's MRI and EF. Examples of simulation and visualization methods will be presented. To make the tools available for the research community, we have created the open-access apps: ELMA and DBSim for performing patient-specific simulations. As a next step DBviS, an app for visualisation and comparison of EF simulation studies will be introduced.
Reference: Wårdell K, Nordin T, Vogel D, Zsigmond P, Westin C-F, Hariz M and Hemm S (2022) Deep Brain Stimulation: Emerging Tools for Simulation, Data Analysis, and Visualization. Front. Neurosci. 16:834026. doi: 10.3389/fnins.2022.834026

Plenary talks session

Thursday morning Plenary
Jun 13, 8:30 - 10:00

PL-8

Transferring scientific findings into medical devices: the power of simplicity

Zlatko Matjačić
University rehabilitation institute, Slovenia

A rehabilitation robot is a device that enables physically disabled people to train, relearn and perform movement. Neurorobotics has a special place in rehabilitation robotics, the goal of which is to increase the intensity of therapy. Wearable exoskeletons, end-effector robots that are in contact only with the walking person's feet, and cooperative robots are used for training of walking. Rehabilitation robots generally help physically disabled people to perform the desired movement, but they may only provide assistance to the minimum necessary extent to maximize volitional engagement of the users. Rehabilitation robots must exhibit soft haptic interaction in contact with the patient, which means that the robotic mechanism must have a high mechanical compliance. Through feedback and virtual reality environments, modern rehabilitation robots motivate patients to exercise more intensively, which increases the therapeutic effects of exercise. Rehabilitation robots must instill confidence in both patients and therapists in the reliability of their operation, and at the same time they must relieve the therapist of heavy physical burden and enable the measurement and objective evaluation of the effects of training.
In the lecture, we will first provide an overview of selected rehabilitation robots that are used in clinical practice for training and assistance of walking. Even though these rehabilitation robots have played instrumental role in acceptance of this kind of technology in clinical practice they have certain shortcomings, mainly reflected in that they physically over constrain users, thus disabling practicing of propulsion and dynamic balance, which are crucial for efficient and safe bipedal walking. A significant factor that impedes the wide-spread use of these devices is their cost that may easily reach up to half a million of

euros. Primarily, the reason for such expensive devices is that they were engineering-driven, thus having many actuated degrees of freedom. However, patients-needs-driven solutions may be significantly less complex enabling easier fulfillment of the regulatory requirements. We will present the evolution of changes in the rehabilitation robot for assessment and training dynamic balance during walking from a complex and expensive haptic device suitable only for research purposes to a simple modular system suitable for industrial realization and use in a clinical environment. The lecture will be concluded with presentation of a Balance Trainer, a passive mechanical device intended for balance training during standing in neurologically impaired individuals that has been successfully on the market of medical devices for more than twenty years and has been sold in excess of 6000 units.

PL-9

Biomedical Engineering for Sustainable Global Health

Leandro Pecchia
Campus Bio Medico University of Rome, Italy

Health systems are facing increasingly complex local (e.g. demographic change, population ageing, sandwich generation) and global challenges (e.g. international health emergencies, antimicrobial resistance, pandemics, climate change, wars, global warming), which led the WHO to introduce among the priorities of the Strategic Plan 2025-2028 the development of climate-resilient health systems and lowering carbon footprint of health systems and societies. There are several factors inspiring this shift in WHO priorities: in May, mosquitoes potential carriers of vector of Zika and Malaria were found respectively in Scotland and Italy; European healthcare systems are responsible for the 5% of Co2 emissions, which is remarkable (e.g., transports account "only" for 15%).
As a proxy for demographic changes, a report from a world leading medical device manufacturer estimated that by 2040 one fourth of the European population should work for the healthcare system, to balance the growing request of care due to aging population. This urges the provision of innovative technologies that can protect healthcare workers (HCW) and free their time from repetitive routinary activities, leveraging on key enabling technologies such as robots, AI, and IoT.
To address these challenges, it is necessary to rethink the organization of health services for the well-being of people and the communities in which they live. To be effective, BME need to work side-by-side with experts of sustainability and strength their collaborations with experts of global health, which are the once in charge for the reorganization of healthcare services in most countries. In fact, the conscious use of enabling and transformative technologies can provide safe, effective, and efficient solutions, while simultaneously generating new knowledge and new opportunities for sustainable economic development, in line with the SDGs. However, the adoption of innovative technologies is effective and sustainable, as well as safe and efficient, if and only if it is accompanied by an actual reorganization of services. Our community is requested to put global effort in finding innovative and sustainable technological solutions, which may help transforming healthcare systems, following the United Nations Sustainable Development Goals 2030 (SDG2030) and in line with the 5As principles: affordability, availability, accessibility, accommodation, and acceptability.
In this talk, Professor Pecchia will give an overview of the work done in the last few years, as WHO Innovation Manger during COVID and in large EU projects (such as GATEKEEPER, ODIN and EPoCA) in order to bridge research and global health ecosystems across different phases of medical devices lifecycle in which BME are involved: design, manufacturing, clinical and pre-clinical validation, regulations, assessment and management.

ORAL PRESENTATIONS' ABSTRACTS

Technologies for assistive and preventive healthcare

Monday morning Track A
Jun 10, 10:30 – 12:15

OR-001

Digitalization of elderly care delivery

Lenka Lhotska, Petr Novak, Jaroslav Cibulka, Vitezslav Mergl

Czech Technical University in Prague, Czech Republic

Society is aging fast and taking care of the elderly is becoming a challenge. The contribution describes ongoing research work started March 2023. Partners from 7 European countries (Austria, Czechia, Germany, Italy, Poland, Slovakia, and Slovenia) identified that the digital solutions that may offer support to nursing staff are still underused. The project focuses on innovative solutions that improve care quality and develops a transnational strategy for digital transformation of care facilities. Two pilot actions are defined for testing deployment of new technologies: digital transformation of care management and delivery; datafication of elderly care delivery, based on environmental, wearable and IoT solutions. Our team focuses on the latter pilot action in collaboration with Gerontology Centre Prague where the pilot solution is tested. The solution consists of three subsystems that can be used either separately, or as an interconnected system.

The first part represents tasks to be used to train and test cognitive abilities and manual dexterity. The aim is to design tasks that are easy to implement and applicable in different environments (long-term care facilities, day care centres, home environment). Data can be stored on a smartphone or computer. Data can be used by both the client and the care staff to provide information about the client's condition (e.g. stable condition, tendency to deteriorate).

The second part represents devices and control options that can be used for a "smart home" solution, but with the requirement for very simple and intuitive operation and the use of simple tools, and reasonable (lower) financial requirement. The acquired data can be used to analyse user behaviour patterns over the long term and thus reveal any degradation of capabilities.

The final part of the proposed pilot study focuses on the introduction of a small social robot into care environment. It can be used both in care facilities and in people's homes. The main goal is to develop an affordable care system that combines smart IoT in the home and a robotic toy (PetBot) as a personalised, friendly and intelligent butler. In the context of the project, the PetBot is an assistive companion with autonomous intelligence, which should understand its "master's" commands and understand how he/she feels. The robot should react adequately to the current situation and, if necessary, offer an adequate and tailored intervention. Thus, the PetBot must know the latest activities in the home and collect and interpret information from various sensors.

The work is supported by the project No.CE0100038 DigiCare4CE of INTERREG Central Europe programme.

OR-002

Design and development of an optical prototype system: Preliminary results

Teodor Minev, Kristina Bliznakova, Nikolay Dukov, *Zhivko Bliznakov*

Medical University of Varna, Bulgaria

The aim of this work is to develop and test a complete platform for an optical im-aging system constructed in transmission geometry for both in-vivo and in-vitro imaging. The imaging system comprises of a visible light source, a CMOS cam-era, and an integrated hardware platform, designed for both rotational and linear movements, accommodating the placement of the imaged object. A comprehen-sive software framework is designed and implemented to govern the linear and rotational motions of the platform. The developed platform was tested with three samples to obtain optical images, which are shown together with the images from an optical microscope. Results showed that the prototype system is capable of obtaining planar images within a timeframe of less than 40 seconds. Future work will focus on optimizing image acquisition speed, conducting extensive validation, and expanding the system into three dimensions. This system is intended to complement the innovative prototype X-ray system currently in development by the ELPIDA group at the Medical University of Varna.

OR-003

Screening prediabetes using 1 hour glucose. A simulation model to estimate the lifetime health and economic outcomes

Martina Andellini, Melania Manco, ***Matteo Ritrovato***

Bambino Gesù Children's Hospital, Italy

Background: The current diagnosis method for diabetes patients is based on the 2-h plasma glucose (2-hPG) value during a 75-g OGTT. However, recent robust evidence demonstrates that 1-hour post-load plasma glucose (1-hPG) ≥ 155 mg/dl in those with normal glucose tolerance during the 2-hPG is highly predictive for T2D incidence. The aim of this work is to carry out a health economic analysis to estimate long-term cost-effectiveness of using 1-hPG compared to 2-hPG for screening and for assessing the risk of diabetes over 35 years.

Methods: A Monte Carlo–based Markov simulation model was developed to simulate the long-term (35 years) effects of the two screening strategies, in terms of clinical and cost-effectiveness outcomes. Transition probabilities on disease progression, mortality, effects on preventive treatments and complications were retrieved from the major diabetes studies. Direct medical costs were sourced from published literature and inflated to 2019 Euros.

Results: In the lifetime analysis, 1-hPG was projected to increase the number of years free from disease; to delay the onset of T2D; to reduce the incidence of T2D complications and to increase the QALY gained. Even if 1-hPG diagnosis method resulted in higher initial costs for preventive treatments, long-term diabetes related costs and diabetes-related complications costs were reduced. The incremental cost-effectiveness ratio was -8,214.7€ per each QALY gained.

Conclusions: Notwithstanding the higher initial costs of screening prediabetes by using 1h-PG due to the incremental preventive treatments, it is feasible and cost-effective resulting in quality of life gained (QALYs) and reduced overall costs.

OR-004

Quantifying static and dynamic balance for the sit to stand movement assessment

Athia Haron[1], ***Glen Cooper***[1], Helen Dawes[2], Maedeh Mansoubi[2], Andrew Weightman[1]

[1]University of Manchester, United Kingdom

[2]University of Exeter, United Kingdom

Maintaining mobility is crucial, for preventing frailty and sustaining independence in older adults. Mobility requires both agility and balance during everyday activities. Maintaining safe mobility without increasing the risk of falls is of concern in almost 50% of older adults. As such, there is increasing interest in measuring and monitoring mobility and balance in a more dynamic way. Innovation in digital technologies now provides a means of to monitor dynamic balance in community settings, generating the need for new definitions of dynamic and static balance during daily activities. To achieve a working definition we carried out 1) a literature review 2) provisional data collection 3) a consensus working group in a sit-to-stand activity, The literature search analyzed 160 papers to define static balance as the relative positioning of the center of mass (CoM) to the base of support (BoS) from multiple definitions of static balance. The literature highlighted that both static and dynamic balance is fundamentally linked to CoM positioning relative to BoS, with dynamic balance incorporating a velocity component for CoM during movement. A 2D analysis of static and dynamic balance during the sit-to-stand activity was conducted on a healthy individual which split the movement into 4 phases (i) torso leaning (ii) bottom lifting (iii) hip extension and (iv) standing. A semi-quantified dynamic balance analysis using the CoM position relative to the base of support, D, and CoM velocity, V, was conducted. The consensus working group observed that a function which minimizes the vector sum total involving these parameters may be crucial to maintaining dynamic balance during this activity of daily living.

OR-005

Design of a Surgical Device for Performing Percutaneous Dilatational Tracheostomy

Yuan Tang[1], Glen Cooper[1], Bruno Adorno[1], Brendan McGrath[2], Andrew Weightman[1]

[1]School of Engineering, University of Manchester, United Kingdom

[2]Manchester University Foundation Trust Wythenshawe Hospital Intensive Care Unit, United Kingdom

Percutaneous Dilatational Tracheostomy (PDT) is a routine bedside procedure performed on patients managed in Intensive Care Units (ICUs). Severe perioperative complications exist, and some, such as major bleeding and tracheal wall perforation, may be caused by operator errors when using PDT instruments,

especially inserting and removing the needle and dilators. We designed a new device called TrachyPen for performing PDT puncture and dilation to reduce the complications associated with current PDT instruments and improve the procedure. The design followed the requirements developed from a questionnaire to twenty-one healthcare professionals, which mapped the mechanical design to the clinical needs. Either used manually or powered by a motor, the TrachyPen is designed to combine the PDT puncture, guidewire insertion, and dilation into a single step, eliminating the use of multiple instruments. Five healthcare professionals evaluated the conceptual design through a demo video and an online questionnaire. A structural analysis of the key parts was completed to evaluate the strength of the design. The results reinforced the feasibility and usability of TrachyPen in terms of matching the design requirements and clinical perspectives.

OR-006

Telemedicine system for prehabilitation in urogynecology

Petra Sládková[1], Marie Tichá[1], Radim Kliment[2], Jan Mužík[2], Marek Doksanský[2], Karel Hána[2], Pavel Smrčka[2]

[1]Bulovka University Hospital, Czech Republic

[2]Czech Technical University in Prague, Czech Republic

Among the most common problems that bother women after childbirth and after menopause, the descent of the pelvic organs associated with incontinence is one of the most common. One option that can be used to address this problem is laparoscopic sacrocolpopexy. This surgical procedure is time-consuming and poses a great burden to patients.

Therefore, intensive preparation of patients in the form of prehabilitation is appropriate. It improves cardiorespiratory parameters and overall physical fitness before surgery, reduces perioperative complications and enhances recovery.

A pilot study tested a telemedicine system for prehabilitation lasting 3 months before surgery. The system allows the collection, interpretation and sharing of patient data, using a mobile app and a respiratory trainer. The mobile app provides visual feedback during training. All measured data is transferred automatically via the web portal. Here, the data is stored and displayed in the form of graphs and tables. Both the therapist and the patient can continuously monitor the results of the training. The effect of the prehabilitation intervention was assessed using objective functional tests: spirometry, Six Minute Walk Test, Borg Rating Of Perceived Exertion, Five Times Sit to Stand test, Hand Grip, ICF - International Classification of Functioning, Disability and Health. Subjective tools (Numerical Rating Scale, WHO-DAS 2.0-WHO Disability Assessment Schedule questionnaire) were also used.

In a pilot study, we tested the applicability of the system in patients before urogynecological surgery. Interim evaluations showed significant improvements in most functional tests. The use of the telemedicine system contributed to improvements in compliance, physical fitness, as well as selected respiratory parameters. Patients found the training motivating, easy to understand and user-friendly. This system appears to be a suitable and affordable tool for routine use in prehabilitation in urogynecology. Potential use can certainly be in other fields of medicine as well.

OR-007

Current Challenges and Future Outlook for Extended Reality as Cutting-edge Assistive Technology shaping Caring Personnel

Fabiano Bini, Michela Franzò, ***Alessia Finti***, Franco Marinozzi

Sapienza University of Rome, Italy

In 2019, the World Health Organization estimated that more than 1 billion of people in the world needed assistive technologies (AT). Among them 970 million needed low vision aids, 35 million prostheses, 75 million wheelchairs, 94 million hearing aids, 150 million mobility aids and 150 million cognitive aids. Based on a EUROSTAT data from 2020, in Europe around 3.7 million practicing caring personnel were registered. Several research sug-gests that new AT are needed and that Extended-Reality may be an adequate option in a contexts where smart homes are within everyone's reach.

In this study a proof of concept on the possibility of use Extended-Reality as an AT for daily-life activities is presented. Several and personalized MR strategies are proposed aiming at improving the lives of elderly people or young people with learning and cognitive difficulties. The aim is to reduce discrimination and inequalities supporting persons with disabilities to fully enjoy their rights and freedoms on an equal basis with others. In this pro-posal, the

figures of the caring personnel and caregiver are taken into con-siderations, providing integration to the traditional social-care methods. The need for prepared and trained personnel to adequately and autonomously manage the new AT is evident as well as the introduction of the social-care professionals with the role of intermediary between the caregiver and caring personnel, who takes care of the patient on a daily basis, and the doctor, with the aim of providing support in the use of AT actively according to medical indications.

S21 - The role of Large-Language Models and Generative AI in Health Technology Management

Monday morning Track B
Jun 10, 10:30 - 12:00

OR-008

Proposal of an XML standard protocol for Evidence-Based Medical Equipment Maintenance

Alessio Luschi[1], Fabio Crapanzano[2], Francesca Satta[3], Lorenzo Sani[2], ***Ernesto Iadanza***[1]
[1]Department of Medical Biotechnologies, University of Siena, Italy
[2]School of Engineering, University of Pisa, Italy
[3]Departement of Health Technologies, ESTAR, Italy

Hospital environments are becoming more and more complex due to technological advancements. The allocation of resources, especially during events like the SARS-CoV-2 pandemic, is becoming crucial, leading Clinical Engineering and Health Technology Management professionals to adopt evidence-based strategies for maintaining the reliability of medical equipment. Real-World Data (RWD) is leveraged to generate Real-World Evidence for assessing the effectiveness and safety of health technologies. Evidence-based maintenance, a systematic process crucial for superior healthcare services, uses empirical RWD to identify effective maintenance strategies.

The study aims to propose a standardized XML schema for data exchange, linking maintenance activities with hospital systems while incorporating maintenance data classification. This approach aims to overcome data-sharing challenges while providing insights into maintenance effectiveness and assessment.

OR-009

Advancing Clinical Decision Support with Large Language Models: A Framework for Guideline-Compatible Hepatitis C Management

Simone Kresevic[1], Mauro Giuffrè[2], Milos Ajcevic[1], Lory Croce[1], Dennis Shung[2], Agostino Accardo[1]
[1]University of Trieste, Italy
[2]Yale School of Medicine, Yale University, Italy

Background: Large Language Models (LLMs) have the potential to optimize healthcare by making clinical guidelines more accessible to providers, thus enhancing guideline adherence and Clinical Decision Support Systems (CDSSs). However, guideline adherence, especially in managing Hepatitis C Virus (HCV) infection is suboptimal. The development of scalable and dependable interventions is crucial for the implementation of medical guideline-conforming care and for addressing discrepancies in adherence.
Nonetheless, the varied format of clinical guidelines presents challenges in accurately interpreting and retrieving relevant information.
An LLM-based solution in healthcare must adhere to the principles of Honesty, Helpfulness, and Harmlessness (HHH). To achieve this, strategies like Retrieval Augmented Generation (RAG) and Fine Tuning (FT) could be considered. RAG is preferred for its flexibility and efficiency and dynamically integrates up-to-date information without frequent retraining, unlike FT, which is resource-intensive and requires retraining for new guideline updates. However, heterogeneity in the format of clinical guidelines—including text presentation and the use of visual aids like tables and flowcharts—poses challenges for the accurate interpretation and retrieval of pertinent information. We aimed to evaluate the feasibility of integrating LLMs into CDSS to improve guideline adherence.
Materials and Methods: The ablation study was performed by investigating the influence of various steps in formatting the European medical guideline on HCV management. Five frameworks based on the LLM developed by OpenAI - Generative Pre-Trained model (GPT) 4 - with RAG strategy were developed, each differing in their approach to leveraging in-context learning, structured formatting of clinical guidelines, custom prompt engineering, and the conversion of tables to lists. A 20-question test set based on the entire

guideline was defined to assess which is the optimal framework configuration. The overall accuracy of the various outputs was qualitatively assessed by two clinical experts. Each experiment was compared with the baseline GPT4.
Results: The performance across all inquiries improved from 43% of accurate responses with the OpenAI GPT-4 to 99% of accurate answers generated by our best-proposed framework ($p<0.001$). The ablation study highlighted enhancements through structured formatting of the guidelines, transformation of tables into lists, and refinement in prompt engineering.
Conclusion: Our study showed the capability of a framework based on an LLM to generate clinical responses HHH-principle compliant and consistent with established guidelines. The results underscore the potential of meticulous guideline structuring and sophisticated prompt engineering in the incorporation of LLMs into CDSSs. This approach opens avenues for the deployment of LLMs in clinical settings, offering a path toward dependable and streamlined applications.

OR-010

Unveiling a New Resource for Crossing Linguistic Frontiers in Biomedicine: A Preliminary Study on English-Italian Translation

Luca Bacco, Mario Merone, Leandro Pecchia
Campus Bio Medico University of Rome, Italy

Introduction: In the field of Machine Translation (MT), the biomedical domain represents a significant frontier, left partially unexplored, due to its uncharted complexities and the critical need for accuracy and reliability. Recognizing the growing need for highly reliable and domain-specific translation tools in the biomedical field, we collected a dataset of over 28k parallel texts, ranging from brief sentences to longer paragraphs, between English and Italian, to provide MT researchers with a valuable resource for addressing the unique challenges presented by the technical and specialized language used in biomedicine.
Methods: To assess the resource's potential, we conducted a preliminary investigation. We utilized the Helsinki-NLP model based on the MarianMT framework for our experiments, chosen for its efficiency in training and inference times compared to larger models and its extensive suite of language pairs accessible from the Hugging Face hub, thus allowing for consistent comparisons across different languages in future developments. Following tokenization, we selected texts with 10 to 128 tokens to ensure meaningful yet manageable translation content, dividing them into training, testing, and validation sets in an 80:10:10 ratio. We then employed a cross-entropy loss function for training the model to translate from English to Italian.
Results: To quantify improvements, we measured the model's performance before and after tuning using a standard metric in the MT field, the BLEU score.
Such a score, which assesses the closeness of machine-generated text to human translations based on n-grams (contiguous sequences of n tokens) matching (we employed n up to 4), improved from 0.39 to 0.53 post-tuning. Additionally, we conducted a qualitative inspection of the translation results, which allowed us to verify the trained system's capability to accurately translate words pertaining to the domain-specific lexicon. We indeed observed successful translations of terms like "strabismus" to "strabismo" and "flukes" to "trematodi", which prior to tuning the model left untranslated, or translations of terms like "dry eyes" to "occhi secchi" and "tear" to "lacerazione", instead of the less accurate "occhi asciutti" and "lacrima" terms, respectively, provided by the model before tuning.
Conclusions: While the unrefined model has shown a discrete level of understanding and ability to translate between English and Italian within the biomedical domain, there was a significant improvement showing the validity of the followed approach and the developed resource. Looking forward, we aim to broaden our dataset to include more languages and to evaluate additional models, including multilingual options.

OR-011

Prompt Engineering for Consistent Healthcare Responses in LLMs

Ali Salman
University of Siena, Italy

Unlock the transformative potential of Prompt Engineering in Large-Language Models (LLMs) for consistent healthcare responses. Emphasizing its critical role, we dig into how prompt engineering optimizes LLMs, rectifying hallucinations, enhancing symptom analysis, and ensuring accurate diagnostics for personalized treatments. Ex-

plore prompt design complications and their guidance of LLMs to generate reliable healthcare responses, improving performance and consistency. Addressing LLM hallucinations, engineered prompts mitigate erroneous outputs through case studies, refining prompts to correct misleading information and enhance response reliability. Discuss achieving consistent, evidence-based healthcare responses through engineered prompts, ensuring LLM adherence to medical knowledge, and grounding diagnostic decisions and treatment recommendations in sound principles. Learn how Prompt Engineering empowers LLMs to analyze symptoms effectively, providing clinicians with relevant information for decision-making. Explore personalized treatments facilitated by tailored prompts, aligning LLM-generated recommendations with individual needs, preferences, and medical histories. Join us to unlock Prompt Engineering's capabilities in LLMs and explore its profound implications for reliable diagnostics and personalized treatments in medicine and healthcare.

OR-012

Natural language processing in dermatology: an overview

Alessandra Cartocci, Alessio Luschi, Linda Tognetti, Pietro Rubegni, Gabriele Cevenini, Ernesto Iadanza

University of Siena, Italy

Dermatology is one of the clinical fields most focused on image acquisition; however, most of them are correlated to written text. In addition, for many dermatological conditions, a biopsy is required to confirm the diagnosis, which is then analyzed by dermatopathologists. The dermatopathologist writes a descriptive text of what they have observed as well as the diagnosis. This research aims to conduct a study of the literature about the use of natural language processing in dermatology.

Using the search terms "((natural language processing OR large language models) AND (dermatology OR dermoscopy OR dermatoscopy)) NOT (chatgpt OR chat-gpt)" a review of the literature was conducted on Pubmed and Scopus. 99 original articles were obtained. Abstracts, reviews, and non-English articles have already been removed. After reading the abstract or the article if the abstract was not sufficiently clear, 43 out of 99 articles were further excluded since they were they were not relevant to the goal of this research.

About 50% of the remaining articles are focused on the use of large language models for the extraction of tumor prognostic parameters for both basal cell carcinoma and melanoma. Three articles use natural language processing to connect dermoscopic images with language descriptions. The remaining articles analyze, with large language models, the patients' comments posted on Reddit (1 on Instagram). In particular, these comments come from people suffering from inflammatory skin diseases such as psoriasis and atopic dermatitis, which create great discomfort in the patient due to itching or pain. These models provide insight into the quality of life and mental state of these patients.

In conclusion, these techniques can be valuable from a clinical point of view. Above all, large language models can make a good contribution to a more accurate definition of tumors, and they can allow us to extract in a structured way many key features and information that can only be extracted from histopathological reports. This allows us to exploit this information to develop further predictive or patient management models. The evaluation of the quality of life of patients is also not to be neglected. It should be considered that this parameter is one of the primary outcomes used to evaluate a treatment, as inflammatory skin diseases are often very disabling.

S02 - Advances in BME in the Asia Pacific Region

Monday morning Track C
Jun 10, 10:30 - 12:00

OR-013

Smart Wearable Haptics for AI Healthcare and the Health Metaverse

Chwee Teck Lim

National University of Singapore, Singapore

We explore the transformative synergy between wearable haptic technologies and artificial intelligence (AI) in shaping the future of healthcare. As advancements in AI continue to revolutionize healthcare, integrating wearable sensors and haptic devices into AI and the health metaverse holds immense potential to enhance patient experiences, diagnosis, and treatment modalities. We will delve into the innovative applications of our unique wear-

able haptics, ranging from real-time monitoring of patients undergoing rehabilitation to interactive simulations for medical training. Additionally, the Health Metaverse concept is introduced, highlighting the integration of AI-driven virtual environments into healthcare practices. With such applications, we hope to gain insights into the promising intersection of wearable haptics and AI, paving the way for more personalized, immersive, effective and accessible healthcare solutions.

OR-014

Silk-based Enthesis Regeneration in Anterior Cruciate Ligament Reconstruction

James Goh

National University of Singapore, Biomedical Engineering, Singapore

The fibrocartilaginous type enthesis interfacial tissue provides the strength to secure ligament to bone. In surgical reconstruction of ACL with tendon graft, optimal healing of the tendon graft within the bone tunnel is not adequately achieved. Therefore, the proposed solution involves the use of a silk fibroin (SF)-based sheath, loaded with nanoparticles of low crystallinity hydroxyapatite (nHA), and sleeved onto tendon autografts to complement their use and promote enthesis formation. The sheath was sutured onto both ends of the graft and pulled through both femoral and tibial bone tunnels in a porcine ACL reconstruction model. All animal experiments were approved by the respective IACUC. The enhancement in osteointegration of tendon autograft was evident within the femoral and tibial ends of the graft from as early as 1-month post reconstruction. Continuous host integration and bone remodeling were observed through the 9 months period, with significant bone tunnel narrowing in the test groups observed by the end of the study. Mechanical study showed that the sheaths enhanced graft tensile strengths. The SF-based sheath serves as delivery platform for cellular and bioactive components. Progenitor cells attracted from the host into the porous sheath could have reconstitute the native cellular environment of the enthesis by differentiating into chondrocytes and osteoblasts. Consequently, there was enhanced graft-to-host integration progressively over the 9 months implantation period, which resulted in overall mechanical properties closer to that of the native bone-ACL-bone construct.

OR-015

Advances in BME in Japan: JSMBE leads bio-resilience research to create new scientific principles

Yasuyuki Shiraishi[1], Yumie Ono[2], Takeo Matsumoto[3], Ichiro Sakuma[4], Ryo Haraguchi[5], Tomohiro Kuroda[6]

[1]Tohoku University IDAC, Japan

[2]Meiji University, Japan

[3]Nagoya University, Japan

[4]School of ENgineering, The University of Tokyo, Japan

[5]University of Hyogo, Japan

[6]Kyoto University, Japan

Biomedical Engineering serves our physical and mental health amelioration by physiological and psychological functional extension in the declining birthrate and super-ageing population society. The BME technologies may not compensate only for the deteriorated or degraded function as final alternatives; the integrated harmony of biological and biomedical responses from native organs may bring with it the amelioration of the quality of life. Bio-resilience, the activation of natural reaction for remission inherent in the pathophysiological process by biomedical engineering, is a creation of innovative BME for sustainable societies and ecosystems to realise a sophisticated quality of daily life. To develop well-being BME technologies based on bio-resilience activation, innovative biomedical approaches, such as modelling and simulation, which are capable of describing the biological control methodology and environmental responses theories and measuring for electively obtained from humans and the environment through preclinical and clinical situations, that may provide appropriate biological and physiological dynamic responses, will establish great promise in the treatment of various diseases.

This presentation will highlight case studies on bio-resilience research and provide an overview of project-based networking.

OR-016

Automatic ROI Delineation for Semi quantitative Analysis of Brain SPECT Imaging at Striatum

Kang-Ping Lin

ChungYuan Christian University, Taiwan

Single-photon emission computed tomography (SPECT) imaging, a relatively inexpensive nuclear imaging technique, has been used

as a diagnostic tool for Parkinson's disease (PD). The tracer 99mTc-TRODAT-1 is commonly used in Nuclear Medicine, where the imaging cost is affordable for low and common health insurance system. However, poor TRODAT-SPECT imaging resolution is a problem. Therefore, we developed a semi-quantitative program that can perform automatic region of interest (ROI) delineation for semi-quantifying striatal dopamine transporter activities. A total of ~200 subjects were enrolled in this study, including PD patients and healthy controls.. The subjects received a 99mTc-TRODAT-1 brain SPECT scan. Some of the subjects also received a high-resolution magnetic resonance imaging (MRI) scan for the evaluation of the accuracy of the semi-quantitative assessment. In addition, the developed automatic ROI delineation method was used to calculate the striatal specific uptake ratio (SUR) in dopamine transporter imaging. The reproducibility of the SUR obtained using the method was compared to those in previous studies. Based on linear regression analysis, a good correlation was found between the results obtained using the automatic ROI delineation method and those of the manual method in striatum with the corresponding MR images. The age-related decline of SUR availability measured in this study was 6.4% per decade. There was almost no difference between our results and those in related clinical studies. The proposed automatic ROI delineation program for SUR analysis was tested and used to estimate the ROIs in TRODAT-SPECT images to aid PD diagnosis. The program could be helpful for physicians who are inexperienced with TRODAT-SPECT images.

OR-017

Soft Robotics for Healthcare

Raye Chen-Hua Yeow

National University of Singapore, Singapore

Soft robotics is a rapidly growing field that is revolutionizing the way we think about robots. From the early days of Ecoflex actuators, soft robotics has now exploded into an extensive spectrum of topics including advanced materials, wearable robots, xenobots, sustainability and learning-based control. Compared to traditional robots, soft robots are made of soft compliant materials with infinite degrees of freedom, which allow them to interact with living things and delicate objects in a more natural and safer manner. In this talk, I will share about the variety of interesting ideas that were developed in my group, from fabrication techniques, material development, actuator/sensor mechanisms, to modular, reconfigurable and bio-inspired systems. I will also discuss about the technology readiness levels and commercialization potential of some of these ideas, and how we evolve them from research lab prototypes to now fully functional industry-grade systems with compelling healthcare applications.

OR-018

A Novel Direct Left-Ventricular Puncture Cannulation Extracorporeal Continuous Flow Blood Pump for Emergency Cardiac Support

Francis Chikweto[1], Yasuyuki Shiraishi[1], Hanako Suzuki[1], Aoi Fukaya[2], Kazushi Ishiyama[1], Tashihiko Kijima[3], Tomoyuki Yambe[1]

[1]Tohoku University, Japan

[2]Tohoku Bunka Gakuen University , Japan

[3]C&T medical Labo, Japan

Heart failure (HF) is one of the leading causes of death worldwide, presenting a global health challenge. Mechanical circulatory support (MCS) devices play an important role in providing hemodynamic support to patients with either end-stage heart failure or acute heart failure conditions. Recently out-of-hospital emergency cardiac arrest cases are on the rise as the super-aging society population proportion increases. The development of short-term compact percutaneous MCS devices ideal for emergency acute heart failure applications is one of the promising advances in MCS technologies. In emergency and acute HF conditions, short-term percutaneous and extracorporeal MCS devices are a cornerstone in providing hemodynamic support where the survival of the patient can be secured quickly. Generally, during extracorporeal hemodynamic support preparation, the cannula and the pump are configured separately and during cardiac arrest, quick initiation of circulatory support is very crucial in order to minimize permanent brain damage. This study proposes a novel extracorporeal cannulation-type mechanical circulatory system, a compact centrifugal blood pump capable of quick installation and starting of hemodynamic support in the emergency cardiac arrest for recovery after cardiac arrest by direct left ventricular apex puncture based on Seldinger's technique. Through numerical simulations, elucidation of the pump's hydraulic

performance, flow patterns as well as shear stress was achieved. Simulation results showed that at 7000 RPM rotation speed, the pump's flow output was 5.0 L/min against a 120mmHg pressure head with 17.2 % pump efficiency. The average wall shear stress on the pump's volute and impeller walls was 63.0Pa and 107.2Pa, respectively. Furthermore, the simulation results showed the capability of the proposed compact blood pump to generate sufficient pressure in good agreement with the hydraulic test results. In vitro hemolysis tests using fresh goat blood for 3 hours, the normalized hemolysis index (NIH (mg/100L) of the pump was 0.0052 for 1.0 L/Min and 100 mmHg conditions. The proposed novel cardiac arrest intervention approach may be considered in future as an alternative and quick auxiliary mechanical circulatory support modality.

S07 - Electrochemical Effects in Bioelectrical Therapies

Monday afternoon Track A
Jun 10, 14:15 - 15:30

OR-019

Unwired bipolar electrodes in neural systems. Main aspects of wireless electrochemistry in biological systems

Nieves Casan-Pastor
Institut de Ciencia de Materials de Barcelona, CSIC, Spain

Electrical activity underpins all life, but is most familiar in the nervous system, where long range electrical signalling is essential for function. The use of external fields can compensate for at least some functional deficits, if they occur. However, its potential to also promote repair at the cellular level has only been demonstrated in vitro. Although there is consistent evidence that external electric fields promote cell growth, not much attention is given to the electrode materials. Furthermore, electrodes are usually connected to the power source. Recently a new possibility has emerged. An external system may polarize a conducting material immersed in the bioelectrolytes, creating a bipolar unwired electrode with induced anode and cathode in opposite poles of the material.
The use of a wireless method to create electrical interactions with a biological system represents a paradigm shift and may allow new applications in vivo where physical wiring is not possible. Several key aspects are observed: The global impedance changes in the cellular media when conducting materials are immersed even if no percolation does exist; the material itself, when mixed conducting systems are chosen, offers a significant redox and ionic gradient across, that expands stimulation in time even after the external field is off; changes in resistivity occur at the material that create complex dipoles and oscillating behaviours. Therefore, neurons are exposed to a variety of voltage gradient profiles, depending on the material and the electric field protocol. As a consequence, different neural behaviours are observed. In some cases, the speed of growth is enhanced, while in others, neurite growth turns towards one of the poles. This work will show a summary of the local resolution studies that evidence the redox and ionic gradients. Finally, additional properties with influence on the biological system are considered, like the in situ generation of volatile or permanent ferromagnetism on the material implanted, with possible future applications. This strategy emphasizes how nerve growth can be encouraged at injury sites wirelessly to induce repair, and how we may benefit from the induced fields in polarized conducting materials to achieve localized therapies.

OR-020

Electrochemistry of neural stimulation

Jiří Ehlich
CEITEC, Czech Republic

Electrical neural stimulation, an essential technique in neural engineering, typically employs charge-balanced biphasic current pulses to elicit action potentials in excitable tissues. While the cathodic phase depolarizes cells to initiate action potentials, the anodic phase serves to revert any byproducts of electrochemical processes to their original state, underpinning the perceived safety of these methods for chronic applications. However, the assumption of complete reversibility of the electrochemical reactions at the electrode-tissue interface is not entirely accurate. Certain byproducts of these reactions, which may be irreversible, pose potential risks to tissue or may function as signaling molecules. The true scope and identity of these reactions remains largely unknown.
In this work, we investigate the primary electrochemical reactions that occur during

electrical stimulation of neural tissues. We provide a detailed analysis of oxygen reduction reactions, which result in the depletion of dissolved oxygen and the build-up of reactive oxygen species, such as hydrogen peroxide. Additionally, we explore the electrolysis of water, leading to the generation of hydrogen and oxygen gases and alterations in local pH levels. The oxidation of chloride ions, resulting in the formation of hypochlorite, and the dissolution of electrodes in chloride-rich environments are also key areas of our study.
Our methodology utilizes amperometric/potentiometric microsensors and spectrophotometric assays to monitor changes in the substrates/products of these reactions. This approach enables us to determine the necessary electrode overpotentials required for these reactions to occur on specific electrode materials. We conduct these studies in standard electrolytes and more complex mediums designed to mimic real physiological environments. Subsequently, we assess the extent of these reactions in the context of standard biphasic stimulation protocols.
This research provides vital insights into the often-overlooked electrochemical aspects of neural stimulation, highlighting potential risks and laying the groundwork for safer, more effective stimulation strategies.

OR-021

Electrolytic Electroporation for Tissue Ablation

Mary Ho
Quinnipiac University, United States

Electrolytic electroporation is a tissue ablation modality that combines the electrochemical effect of electrolysis with electroporation. Electrolysis alone uses a low-magnitude direct electric current to create chemical species at the electrode-tissue surface which then diffuse through the tissue, resulting in extreme pH changes and cell death. Electroporation, on the other hand, uses pulsed electric fields to create permeabilizations in the cell membrane. Irreversible electroporation results in cell death by loss of cell homeostasis. It is hypothesized that electrolytic electroporation produces low levels of electrolytic product that are able to penetrate within the electroporated cells, resulting in a new method of tissue ablation. This method has shown promise for increasing the ablation volume when compared to traditional irreversible electroporation, enabling cell death in the surrounding reversibly-electroporated zone. Here, we review advances in the field of electrolytic electroporation and look at potential future applications.

OR-022

Leveraging the Electrochemical Reactions from Electroporation to Promote Anti-Tumor Phenotypes in Immune Cells

Zaid Salameh[1], Manali Patwardhan[2], Alana Hay[2], Joanne Tuohy[2], Rafael Davalos[1]
[1]Georgia Institute of Technology, United States
[2]Virginia-Maryland College of Veterinary Medicine, United States

Low pH is a defining characteristic of an immunosuppressive tumor microenvironment and is a hallmark of cancer. This oncogenic trait, which arises due to the metabolic reprogramming of cancer cells, promotes immune evasion in part through phenotypic changes in resident macrophages. Although tumor acidity is correlated with a poor prognosis, there are minimal therapies which leverage alkalinity as a possible therapeutic. Electrochemical reactions occur at the electrode/medium interface when a voltage is applied across tissue. This elevates and decreases the pH at the cathode and anode, respectively. Here, we demonstrate cathodic electrochemical reactions can be isolated and applied to elevate the pH in liver tissue and promote an anti-tumor phenotype in macrophages. In our custom in vitro platform, Hep G2 (hepatocellular carcinoma) cells were exposed to irreversible electroporation treatment and increasing dosages of alkalinity before coculture with THP-1 macrophages. The macrophages were then characterized for antitumor surface marker expression. Our data shows that a targeted increase in pH through the cathode electrode activates naïve macrophages in vitro. With appropriate electrical dosing, this technique has the potential to further enhance the anti-tumor immune response following electroporation-based treatments.

OR-023

Beyond the rainbow: A validated mechanistic model of electrochemically produced pH changes in tissue

Rok Šmerc, Damijan Miklavčič, Samo Mahnič-Kalamiza
University of Ljubljana, Slovenia

In various biomedical applications, the oc-

currence of pH changes in tissue due to water electrolysis, commonly referred to as hydrolysis, is a notable phenomenon. One such example is electroporation, wherein the permeability of a cell membrane is transiently increased after exposure to an electric field of sufficient amplitude, allowing increased uptake of ions and molecules. In numerous therapies using electroporation, such as gene transfer or drug administration, minimising tissue damage is critical, with pH changes being a potential contributing factor alongside others. Numerical modelling serves as a valuable tool for the assessment of electrochemically produced pH changes in tissue.

The aim of this study was to build a comprehensive mechanistic numerical model of the pH changes in tissue during and after the application of electrical pulses with parameters typical for electroporation and to subsequently validate this model experimentally. The model is based on the Nernst-Planck system of equations for the concentration of ions in a four- (unbuffered) or seven-component (for the bicarbonate buffer) electrolyte. The system consists of four or seven partial differential equations, depending on whether a buffer is considered, which represent the spatial concentration of ions for each species under consideration. In addition, the last equation describes the spatial distribution of the electric potential in the electrolyte. The model was developed using COMSOL Multiphysics software and considers two mechanisms of ion transport: diffusion, driven by the concentration gradient, and migration, driven by the gradient of the electric potential. Convection is assumed to be insignificant and therefore neglected.

The results of the model were verified through experiments conducted in agarose to which various pH indicators were added: methyl red, bromothymol blue, and phenolphthalein. To accurately monitor the pH changes during the experiments, we developed and calibrated a video recording system. This allowed a direct comparison between the experimental results and the calculated results of the numerical model.

Our study presents a successful development of a mechanistic model of pH changes in tissue during electroporation, along with the establishment of an experimental protocol using agarose as a mock tissue medium. Furthermore, our results show a good agreement between the modelling results and the experimental observations.

S26 - IFMBE Education in BME: Transformation of the BME Education in Asia Pacific Region

Monday afternoon Track B
Jun 10, 14:15 - 15:30

OR-024

A new framework of BME education with medical focus at CYCU, NYCU and NCKU in Asia-pacific region

Kang-Ping Lin[1], Tse-Ying Liu[2], Ying-Hui Lai[2], Wen-Tai Chiu[3], Ming Chen Wang[1]
[1]ChungYuan Christian University, Taiwan
[2]National Yang Ming Chiao Tung University, Taiwan
[3]National Cheng Kung University , Taiwan

Department of Biomedical Engineering (BME) is uniquely an Inter-disciplinary department, which is combined with engineering and scientific technology applied to biology, medicine and medical treatment in university. In the Asia-pacific, more and more universities with engineering subjects have continuously established BME major department or a BME department ranging from an undergraduate to a Ph.D. program. In the Asia-pacific, the areas of expertise for BME education are usually classified as biomedical electronics, biomedical materials, tissue engineering, biomechanics, biomedical imaging, biomedical information etc. Regarding course design, BME education courses are classified totally ~30% as "foundation core courses" including mathematics, anatomy and physiology etc., and ~40% as "professional required courses" including medical instrumentations, biomaterials, biomechanics, off-campus internships and subject practice etc., which are required as graduate of 70~100 credits in BME. Course credits from the "subject practice", which are required as graduate credits ranging between 4 and 12, and 6 is the most common, in which different graduate credits are required in different countries. In addition, course credits from the "off-campus internships", which has been emphasized and considered as necessary in the region, are also required as graduate credits. Before graduating, students are required accomplish off-campus internships in relevant institutions, which is equivalent to required credits ranging between 2 and 5. In some universities,

the "subject practice" and the "off-campus internships" are combined. A subject for the "subject practice" can be chosen from the "off-campus internships" to research on cases in the internship field, which will be conducted under the supervision of a supervisor in the field. The subjective is for students to understand the role of clinical workflows in the medical institution and their practical operation, to experience the practical operation in hospital or healthcare related institution, to obtain clinical professionally knowledge and applications, to experience the working environment in the hospital and the way to work with colleagues. In addition to the training content of the above courses, there are some new training structures, which especially strengthen the training of medical knowledge for engineering students and the strengthening of engineering background for medical students. These are very special changes in educational thinking. A summary of three training methods from CYCU, NYCU and NCKU in this area is presented to sharing the experiences.

OR-025

Creating an Authentic Learning Environment in the NUS-BME program

Raye Yeow, James Goh
National University of Singapore, Singapore

Biomedical Engineering (BME) is one of the fastest growing disciplines in the past few decades. It has contributed tremendously to the medical field. However, healthcare industries landscape is changing rapidly due to multiple factors, ie healthcare economics leading to reformation in the healthcare system, major trends in public health, continuing advances in our understanding of human biology that has the potential impact on medical practice and the development of new innovative technologies for effective and precise diagnosis, treatment and monitoring. With advances in technology, in particular the development wearables, data analytics, IoT, artificial intelligence and coupled with industry 4.0, the future of medicine would be very different. The proliferation of health centric devices and digital health will certainly give rise to connected health with increased fitness awareness. Aside from the digital revolution, multi-scale bioengineering approaches are also making impact in healthcare and medicine. As such the field of medical and biological engineering can play a huge role in scientific innovation and translating invention to practice, so as to enhance the healthcare interventions. Therefore, while it is important for BME undergraduate degree program to produce engineers with a strong foundation in the relevant engineering, sciences and technology, it is perhaps as important to emphasize innovation, enterprise and leadership in the BME curriculum. Future BME program will need to have a high degree of flexibility that can provide a wide diversity of educational experiences. By providing graduates with a combination of broad-based fundamentals and specialized knowledge, the BME program strives to graduate versatile biomedical engineers that would be best positioned to lead and be an integral part of the BME industries. This can be facilitated by utilizing effective an efficient pedagogical approach in our teaching. We have looked at the used of a blended learning environment, with concepts belonging to flipped classroom, active and authentic learning paradigms applied to a large undergraduate year 1 biomedical engineering class. The data suggested that firstly, the active learning approach led to enhanced learning, deeper impressions of concepts taught, better engagement of students and additional interest in the subject matter. Secondly, the authentic learning component helped correlate theoretical principles with real life, demonstrate the utility of the concepts taught, and further improved students' engagement and interest. Thirdly, the extensively active and authentic learning design generated moderate enhanced enthusiasm of students towards their major and facilitated a slight shift from performance goal orientation towards learning goal-orientation. Furthermore, BME program needs to address and respond to the rapid changes in technologies and ensuring our ... (abstract was cropped - too long)

OR-026

Current status and features of BME education in China

Hairong Zheng
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

The inception of Biomedical Engineering (BME) education in China, which began 40 years ago with its pioneering program offered by a medical university and leading universities, has since seen a remarkable expan-

sion. Currently, over 100 universities across China offer BME programs at various levels, thanks to the solid foundation laid by the establishment of a national committee dedicated to BME's strategic advancement. China's BME education, now ranked within the top 1% globally, benefits from an outstanding faculty responsible for teaching and leading significant research projects. This excellence is further enhanced by a culture of collaboration across academia, industry, and healthcare sectors. Strategic investments in medical devices, healthcare enterprises, and research breakthroughs, coupled with the integration of artificial intelligence in healthcare, highlight the importance of BME in China's strategic planning. The emphasis on training the next generation of professionals, along with enhancements in the regulatory framework introducing ethical standards and biosafety measures, has attracted both domestic and international students and researchers, thereby increasing the field's global exposure. With ongoing investments and policy support, the outlook for China's BME education is highly positive. Nevertheless, the field's expanding interdisciplinary nature calls for continuous curriculum updates and the development of specialized areas to keep pace with global advancements.

OR-027

Bioengineering education through the promotion of research collaboration of school of medicine and school of engineering at The University of Tokyo

Ichiro Sakuma

School of Engineering, The University of Tokyo, Japan

In the Department of Bioengineering, Graduate School of Engineering, The University of Tokyo, students are required to take courses in the Athe curriculum, which consists of lectures and exercises on basic applications of engineering technology and specialized content related to bioengineering, and to belong to one of the laboratories of the faculty members in the department. Students are required to conduct research in one of the laboratories of the faculty members of the Department for two years in the M.S. program and three years in the Ph.D. program, and to summarize the results in a M.S. thesis and a Ph.D. thesis, respectively. They are also required to give oral presentations at relevant scientific meetings.

The research fields of this department are broadly divided into two areas based on the fundamental academic system: physics, electricity and mechanics, and chemistry, materials and life sciences. The research fields are further divided into the following six areas: mechanobioengineering, biodevices, bioelectronics, bioimaging, chemical bioengineering, and biomaterials. These fields promote academic fusion based on a bird's-eye view and develop innovative medical technologies by constructing fundamental technologies to control the interaction of materials and systems with living organisms. Examples of research topics include medical robots, regenerative medicine technology that takes into account the mechanical response of cells, biochemical measurements using microfluidic devices, drug delivery systems, implantable medical devices using hydrogels, and functional imaging for the analysis of life phenomena. Collaborative research among laboratories of mechanobiology, chemical biology, biomaterials, and bioimaging is also conducted in such an area of physical stimulus-responsive drug delivery systems. Most of the researches are conducted in collaboration with the School of Medicine, including clinical trials using the developed technologies.

Students are encouraged to make full use of the knowledge acquired in the coursework in their own research activities. The activities lead to a deeper understanding of knowledge. In addition, through research activities that involve repeated trial and error and exposure to actual biological phenomena, students do not simply believe that existing knowledge is complete, but rather discover problems and plan and conduct research to gain new knowledge. Through exposure to basic/clinical medicine, engineering students can acquire different ways of thinking than medical and clinical experts. Practical knowledge of risk management required for clinical trials will be helpful in the later stages of regulatory approval of medical devices.

This presentation will present examples of research activities in the Department of Bioengineering at the University of Tokyo and discuss how they can contribute to human resource development.

S03 - Applications of Entropy in Health Care

Monday afternoon Track C
Jun 10, 14:15 - 15:30

OR-028

Entropy-Based Analysis of DNA Sequences and IGHV Mutational Status in Chronic Lymphocytic Leukemia: Predicting Patient Survival

Alexander Martynenko[1], Xavier Pastor[2]
[1]V.N.Karazin Kharkiv National University, Ukraine
[2]University of Barcelona, Spain

This article discusses the use of a combination of mutation status of the immunoglobulin heavy chain (IGHV) gene and entropies of DNA sequence for the analysis of leukemia patients' survival. Using a chronic lymphocytic leukemia (CLL) patient database, the study calculates different entropy measures for each patient's DNA sequence. An entropy maximization algorithm is developed to estimate the statistical DNA information of each patient, allowing for the classification of patients into two groups without relying on population properties. Survival analysis of leukemia patients is conducted by combining IGHV subtype analysis and entropy measurements. Statistical significance is found when comparing groups with high and low entropy, as well as different IGHV subtypes. The analysis indicates that the combination of a mutated IGHV subtype and high entropy of DNA sequence can significantly impact the life expectancy of leukemia patients. The results are validated using Kaplan-Meier survival analysis, Cox regressions, and a Generalized Linear Mixed Model (GLMM). Overall, the study demonstrates the value of combining IGHV gene mutation status and entropy analysis of DNA sequences for leukemia patient survival prediction. The findings high-light the potential for leveraging multiple prognostic factors to improve the identification of patients with varying lifespan prognoses.

OR-029

Evaluating Mental Workload Through Cross-Entropy Analysis of Two Prefrontal EEG Channels

Matin Beiramvand[1], Mohammad Shahbakhti[2], Tarmo Lipping[1]
[1]The Faculty of Information Technology and Communication Sciences (ITC), Tampere University, Finland
[2]Biomedical Engineering Institute, Kaunas University of Technology, Lithuania

The objective of this study was to explore whether cross-entropy metrics provide further insights in comparison to conventional entropy, aiming to enhance the accuracy of mental workload assessment. We initially filtered and segmented EEG signals from two prefrontal channels and decomposed the signals into subbands. Afterward, we calculated a range of cross-entropy and traditional entropy metrics for each sub-band. Finally, these extracted features were fed into an AdaBoost classifier to evaluate mental workload levels. The comparison of classification results demonstrated that integrating cross-sample entropy with sample entropy notably enhanced accuracy by 10%, reaching 84%. Further, utilizing the complete set of cross-entropy metrics yielded an accuracy of 84.5%.

OR-030

Bayesian Shannon Entropy for assessing patient's data interrelation in medical applications

Alexander Martynenko[1], Xavier Pastor[2]
[1]V.N.Karazin Kharkiv National University, Ukraine
[2]University of Barcelona, Spain

This research explores the application of a proposed interrelation index for analyzing patient data in medical contexts. The patient data is represented as either quantitative time series or qualitative sequences. Conditional Bayesian inference rules were developed for both types of data. Shannon entropy was employed for the initial dataset, while Bayesian rules were applied to the randomized dataset. The interrelation index, calculated as the ratio between Bayesian Shannon entropy of the randomized dataset and Shannon entropy of the initial dataset, serves as an indicator of data coherence in time series or sequences. The medical applications of this interrelation index were demonstrated through the analysis of Heart Rate Variability (HRV) in patients with various cardiac diseases and the DNA sequences of a chronic lymphocytic leukemia (CLL) patient with different mutation statuses of the immunoglobulin heavy chain (IGHV) gene. Comparative analyses with normal cases were provided for both medical applications. In essence, the study highlights the utility of Bayesian inference in enhancing the sensitivity and accuracy of entropy-based

analysis for quantitative time series and sequences of qualitative (nominal) variables.

OR-031

Relationship of the Correlation between EEG and Heart Rate Variability with Cardiovascular Indicators

Merilin Vihmaru[1], Laura Päeske[1], Hiie Hinrikus[1], Jaanus Lass[1], Toomas Põld[2], *Maie Bachmann*[1]
[1]Tallinn University of Technology, Estonia
[2]Meliva AS, Estonia

The correlation between electroencephalographic (EEG) and electrocardiographic (ECG) signals can provide important information about cardiovascular regulation. The current study aims to investigate the dependence of the correlation between EEG and heart rate variability (HRV) on cardiovascular indicators. The signals of a group of 30 subjects were divided into two groups of 15 subjects according to the lower and higher indicators of blood pressure and cholesterol. Relative EEG frequency band powers were calculated in theta, alpha, and beta frequency bands. From power spectral analysis of HRV, low frequency (LF) power, high frequen-cy (HF) power and LF/HF were calculated. In the current study, the correlation between EEG and HRV is detected by two HRV features, LF and HF, in the the-ta band, and also by two features, HF and LF/HF, in the alpha band. The correlation by one HRV feature, LF/HF, is revealed in the beta band. The effect of cardiovascular features is reflected by LF and HF features in the theta band and by HF in the alpha band. The novel finding that even a small increase in cardiovascular features (blood pressure and cholesterol) can affect cardio-neuronal regulation is important and needs further investigation.

OR-032

Detecting Heart Failure Relations: A Preliminary Study Integrating HRV, LVEF, and GLS in Patients with Ischemic Heart Disease and Dilated Cardiomyopathy

Katerina Iscra[1], Laura Munaretto[1], Aleksandar Miladinovic[2], Jacopo Giulio Rizzi[1], Marco Merlo[1], Agostino Accardo[1], Milos Ajcevic[1]
[1]University of Trieste, Italy
[2]Institute for Maternal and Child Health "Burlo Garofolo" , Italy

Cardiovascular diseases, such as Ischemic Heart Disease (IHD) and Dilated Cardiomyopathy (DCM), collectively represent the leading cause of mortality worldwide. In both pathological conditions, patients displaying heart failure symptoms emphasize the critical need for early detection, facilitating timely and appropriate care, enhancing patient outcomes, and optimizing healthcare resources. Heart rate variability (HRV), Left ventricular ejection fraction (LVEF) and Global longitudinal strain (GLS) are prominent parameters that could allow the identification of heart failure event. Therefore, the aim of our study was to develop an interpretable model that identify the relation between the occurrence of heart failure and HRV features, as well as LVEF, GLS, sex and age in patients with IHD and DCM. The study encompassed two groups: 126 patients with heart failure (HF group) and 126 patients without it (noHF group). GLS, LVEF, and linear and non-linear HRV features were extracted for each subject. Then, the interpretable model was produced by a logistic regression algorithm considering a set of features chosen with the univariate logistic regression method. The univariate logistic regression results indicate a significative correlation between the occurrence of heart failure events and the following parameters: LVEF, age, expBeta, HFn, and LF/HF. The obtained classification accuracy of produced model was 73% and the area under the ROC curve was 0.77. These preliminary findings showed that the identified parameters may be useful for stratification of IHD and DCM subjects with a risk of a heart failure event.

S08 - Electroporation meets cardiac treatment

Monday late afternoon
Track A
Jun 10, 16:00 - 18:15

OR-033

What do we (think we) know about electroporation

Damijan Miklavčič
University of Ljubljana, Slovenia

Simplistic view on electroporation has hindered development and translation of electroporation-based technologies and treatments from in vitro to in vivo. Scaling treatments to patients has been challenging and reaching visceral targets has been limited. Recent advances in developing Pulsed Field Ablation for treatment of atrial fibrillation

has provided the technology that allows us to consider delivering drugs and genes to cardiac tissue by electroporation. Delivering high voltage pulses to excitable tissue organ with limited to no capacity to regenerate and of such vital importance has revealed many long-known properties and consequences of high-voltage pulse delivery and electroporation (e.g. stunning, interfering with conduction system, causing vascular spasms) but with the potential to deal with epidemic proportions of atrial fibrillation provided commercial interest of largest medtech companies that are providing us with tools to start considering delivering drugs and genes with accuracy and precision unavailable before.

With this opportunity it is time to review if and what we know of electroporation on the membrane, cell, and tissue level; and what is the expected "system" response to high-voltage pulse delivery. The aim is to perform electroporation in a controllable and predictable way to either ablate arrhythmogenic substrate or deliver genes into cells in the heart while avoiding or at least minimizing unwanted effects, e.g. coronary vasospasms, inflammation, thermal damage and off-target effects.

Electroporation, rather than a special phenomenon, should be considered as a (non-specific) injury inflicted to the plasma membrane and consequently to the cell. As such it triggers cell repair mechanisms and stress response. When electroporation is performed in tissue, this injury will cause immune response due to DAMP release. Delivery of high voltage electric pulses will cause transient ischemia due to effect on microvasculature, stunning of cardiomyocytes and lack of action propagation in the tissue due to cardiomyocyte sarcolemma increased conductivity and putative effect on gap junctions. These effects are transient, and cells may recover and regain their normal function. We do not know however, what is the extent of damage that the cell/tissue can sustain, and what is the point-of no return. In Pulsed Field Ablation we would like to know better when and why the cells die, so that we can predict the lesion size. In gene delivery, however, we need to assure nucleic acid uptake and expression of transgenes, their therapeutic levels and duration of expression, or intended cell (genetic) modifications.

OR-034

Initial single centre experience with pulsed field ablation for treatment of cardiac arrhythmias

Matevž Jan[1], Tine Prolič Kalinšek[1], Jernej Iršič[1], Damijan Miklavčič[2], Jernej Štublar[1]

[1]University Medical Centre Ljubljana, Slovenia

[2]University of Ljubljana, Slovenia

Background: Pulsed field ablation (PFA) is an emerging ablation modality for treatment of cardiac arrhythmias, based on irreversible electroporation.

Methods: We investigated procedural parameters and clinical outcomes from our PFA registry. CentauriTM (Galvanize Therapeutics, Inc., USA) PFA system was used. It is connected instead of a radiofrequency generator and thus easily adopted in routine clinical procedures, which were performed in deep sedation between February 21st, 2023 and March 5th, 2024. Follow up included scheduled outpatient clinic visits and ECG recordings guided by symptomatic arrhythmia episodes.

Results: We included 43 consecutive patients where at least one PFA application was delivered. Mainly persistent (53%) and paroxysmal (33%) atrial fibrillation (AF) were treated with pulmonary vein isolation lesion set (81%) as recommended by the manufacturer. For persistent AF isolation of left atrial (LA) posterior wall (47%) was added. Patients were male (65%), mean age 60,6 years, overweight (29,3 BMI). Totally, 92 ± 60 (mean ± SD) PFA applications were delivered per patient, with skin-skin procedural time 171 ± 64 (mean ± SD) min. Acute procedural efficacy was 81% for the whole cohort and follow up procedural efficacy was 60% and 42% for paroxysmal and persistent AF respectively. We observed 3 PFA related complications.

Discussion: Due to proven non-thermal nature of PFA, LA posterior wall isolation was chosen as per our clinical experience and expert consensus, nevertheless one patient had post-procedural esophagitis, that resolved 2 weeks later. Follow up analysis showed, that for this patient higher 25A dose (intended for anterior aspect of LA) was used in LA posterior wall. One patient had acute pericarditis. Coronary spasm presenting with acute ST elevation was noticed in one procedure, while ablating at the ostium of the left inferior pulmonary vein. Additionally, we used PFA in 4 patients after failed radiofrequency ablation of ventricular tachycardia. Despite highest dose (25A) and mul-

tiple applications delivered in the same location, only transient effect was achieved in all cases. This could be because CentauriTM system was developed for ablation of thin atrial wall, thus reaching deeper midmyocardial tachycardia isthmuses only with reversible electroporation field.
Conclusion: Based on small and heterogeneous patient cohort clinical efficacy comparison to the established clinical practice is difficult. Point-by-point PFA seems moderately effective for treatment of AF and ineffective for intramural ventricular substrates. We believe that the biggest advantage of the PFA system presented here is its possibility of toggling between different energy sources especially in the vicinity of neighbouring tissues (oesophagus) during extensive ablation of the LA posterior wall.

OR-035

Numerical modelling in pulsed field ablation

Bor Kos
University of Ljubljana, Slovenia

The use of numerical models in electroporation research has long contributed to the understanding of the medical application of electroporation. Using of these models, the intensity of the electric field, which is the main prerequisite for electroporation, in the target tissue can be precisely controlled. Such personalized treatment planning not only ensures the efficacy of the therapeutic intervention, but also prioritizes patient safety by taking into account additional safety constraints, such as maintaining safe distances from critical anatomical structures and mitigating the risk of thermal injury.
However, the effectiveness of numerical modelling depends on the refinement and adaptation of these computational tools to accurately reflect the intricacies of biological systems and clinical scenarios. An important aspect explored in this presentation is the nuanced impact of myocardial anisotropy and lethal electric field thresholds during electroporation on therapeutic outcomes, which are particularly important in the context of cardiac ablation procedures. By elucidating these factors and incorporating them into numerical models, we aim to improve the precision and reliability of treatment planning processes and ultimately patient outcomes.
Furthermore, the translational potential of this research goes beyond the theoretical realm and finds practical application in the development and refinement of medical devices. The integration of numerical modelling into the design process of catheter-based pulmonary vein isolation technologies is a concrete example of how computational insights can drive innovation in medical technology. This presentation will therefore not only address the theoretical foundations of numerical modelling in electroporation therapy, but also highlight its critical role in driving transformative advances in clinical practice and medical device development and certification.

OR-036

Machine Learning Models for Predicting Electroporation-Dependent Tissue Properties and Temperature Distributions from Pulsed Electric Fields

Edward Jacobs, Pedro Santos, Rafael Davalos
Georgia Tech, United States

Pulsed electric field (PEF) therapies deliver high-voltage, short electric pulses directly into tissue to permeabilizes cells through the generation of nano-scale pores (electroporation). The transitory formation of pores is called reversible electroporation and is used to deliver chemotherapeutics, genes, and impermeable substances into cells. Larger and longer PEFs may induce cell death through loss of homeostasis, termed irreversible electroporation (IRE). IRE was considered the upper limit of reversible electroporation but has been developed as a standalone method for tissue ablation. PEF treatment efficacy depends on the application of a critical electric field over the targeted tissue volume, but the electric field distribution depends on the tissue-specific electrical properties, which both differ between patients in healthy and malignant tissues and change in an electric field-dependent manner from the electroporation process itself.
We use an in situ method, termed voltage ramp, that applies a series of increasing voltages across treatment electrodes and measures the resulting current. Due to the inherent non-linearity in the system, we develop a robust deep neural network, trained on finite element model simulations, to unravel the relationship between V/I characteristics and tissue properties. We found minimal test error ($p < 0.0001$), and our model was validated to correctly predict the complete dynamic conductivity curve in a previously characterized ex

vivo liver model ($p < 0.0001$). Lastly, we characterize and validate the first reported electrical tissue properties of lung tumors from five canine patients. We believe this platform can be incorporated prior to treatment to rapidly ascertain patient-specific tissue properties paramount in electroporation treatment planning models and real-time treatment prediction algorithms. Further, this method can be used over current ex vivo methods for in situ tissue characterization.
The nonthermal mechanisms for IRE are paramount for treating tissue near anatomically sensitive structures. Numerous thermal mitigation protocols have been proposed to minimize temperature rise, but intraoperative temperature monitoring is still needed. We demonstrate here that an accurate and robust temperature prediction machine learning model can be developed using estimated tissue properties (bulk and dynamic conductivity), known geometric properties (probe spacing), and easily measurable treatment parameters (applied voltage, current, and pulse number). We show that the model can predict temperature rise within ex vivo perfused porcine livers, with error <0.5 °C, and is shown to predict temperature rise in over 1000 unique computational test conditions with <1 °C error and no observable outliers.

OR-037

In Vivo Cardioporation Enhanced Myocardial Gene Delivery

Richard Heller[1], Mark Jaroszeski[1], Carly Boye[2], Michael Francis[1], Jacob Hensley[1], Alex Otten[1], Sezgi Arpag-McIntosh[3], ***Anna Bulysheva***[1]
[1]University of South Florida, United States
[2]Wayne State University, United States
[3]Old Dominion University, United States

Damage from myocardial infarction (MI) and subsequent heart failure are serious public health concerns. Current clinical treatments and therapies to treat MI damage largely do not address regeneration of cardiomyocytes. Challenges to gene based cardiac regenerative therapies include efficient delivery to the myocardium and minimizing risk. Our current studies focus on maximizing gene delivery efficiency and minimizing risk associated with pulsed electric field application to excitable cells. We established that it is possible to promote regeneration of cardiac muscle with plasmid DNA encoding vascular endothelial growth factor B delivery directly to the ischemic myocardium. Additionally, we optimized cardioporation parameters to increase expression efficiency by varying electrode configuration, applied voltage, pulse length, and plasmid vector size. By using a surface monopolar electrode, optimized pulsing conditions and reducing vector size, we were able to prevent ventricular fibrillation, increase survival, reduce tissue damage, and significantly increase gene expression levels. Further studies are focused on minimizing action potential stimulation in excitable cells with biphasic pulsing parameters yielding minimal twitching while enhancing gene delivery.

OR-038

Gene electrotransfer – the role of electrical and biological parameters in in vitro experiments

Alenka Maček Lebar
University of Ljubljana, Slovenia

Gene electrotransfer (GET), a method in which foreign nucleic acids (NAs) are introduced into cells using high-voltage electric pulses, is used to treat many individual cells without the use of additional chemicals and within a short time in in vitro conditions, and it is relatively inexpensive, flexible, and has great potential for clinical use. A better understanding of the GET mechanisms, which allow NAs of different types and sizes to enter cells, and the role of experimental electrical and biological influencing parameters could improve the efficiency of GET and expand clinical applications.
To explore the current state of knowledge on the influence of electrical and biological parameters on GET efficiency, we conducted a systematic literature review of GET publications in in vitro conditions and performed a meta-analysis of reported GET efficiency. A systematic literature search up to mid-2022 revealed approximately 4600 papers reporting the use of GET in various research studies and biotechnological applications. The experimental electrical parameters included the type and geometry of the electrodes, the material of the electrodes, the device used to apply the electrical pulses, the amplitude and duration of the electrical pulses, and the method used to measure the output pulses. Biological experimental parameters included the type, dosage, size, the promoter of the NA, the encoded transgene, the number of cells used for EP, whether the cells were electrotransfected in suspension or attached, the cell

line, the origin and type of cell line, and the electroporation medium. Only 23 papers contained all the desired information and were therefore reliable enough to be included in the meta-analysis. The meta-analysis resulted in a pooled overall GET efficiency of 25% (95% CI, 23.8–26.9). The parameters that significantly affected the overall GET efficiency were cell line type, NA promoter, and pulse parameters. Overall, GET was significantly higher in tumor cell lines compared to normal and primary cell lines, and in normal cell lines compared to primary cell lines. GET was also significantly higher when the SV40 promoter was used compared to CMV or other promoters. Considering pulse parameters, exponential and combination of short and long pulses resulted in significantly higher overall GET compared to all other pulses.
Reference: Potočnik T et al. Pharmaceutics 2022, 14, 2700.

OR-039

Precision medicine approach to cell therapy in heart failure

Bojan Vrtovec
University Medical Centre Ljubljana, Slovenia

Aims. The goal of the study was to develop a personalized cell therapy approach to be used as a clinical management in patients with chronic heart failure.
Materials and Methods. In the derivation part of the study we analysed the dataset from 5 cell therapy clinical trials conducted at UMC Ljubljana, enrolling a total of 240 patients with chronic heart failure. We performed machine learning analysis to define individual patient profiles with most clinical benefits after cell therapy. Patient profiles were then used as inclusion criteria in the validation part of the study. In the validation study, CD34+ stem cells were mobilized by 5-day stimulation with filgrastim, collected with apheresis and immunoselection, and injected transendocardially. Patients were followed 1 year after cell therapy.
Results. In the derivation part we identified nonischemic heart failure etiology, lower NT-proBNP levels, transendocardial cell injection, and lower end-diastolic volume (LVEDV) as independent predictors of favorable response to cell therapy. Using these criteria in the validation part of the study, we enrolled 30 patients (male: 93%), aged 51±13 years, with LVEF of 28.4±5.0%, LVEDV of 224±46 mL, and NT-proBNP of 1231±1708 pg/mL. At 1 year after cell therapy, we found a significant improvement in LVEF (+10.5±7.8%, P<0.001), a decrease in NT-proBNP (-530±1430 pg/mL, P=0.001), and an improvement in exercise capacity, measured as 6-minute walk test distance ((+31±58 m, P=0.01). An improvement of LVEF >5% was present in 24/30 (80%) of patients, and a concomitant improvement in LVEF, NT-proBNP, and exercise capacity was present in 18/30 (60%).
Conclusions. The use of strategies based on informing target individuals with the highest likelihood of regenerative response may significantly improve the clinical efficacy of cell therapy in chronic heart failure patients.

OR-040

The LVAD-CD34+ Stem Cell Combination Therapy in Non-ischemic Dilated Cardiomyopathy Patients

Gregor Poglajen, Sabina Frljak, Gregor Zemljič, Andraž Cerar, Bojan Vrtovec
University Medical Centre Ljubljana, Slovenia

LVAD-stem cell combination therapy has only been evaluated as a simultaneous treatment approach (transepicardial cell injections at the time of LVAD surgery) and it failed to show additional benefits of cell therapy, likely due to detrimental effects of surgery-associated systemic inflammation on injected cells and failing myocardium. We aimed to evaluate the safety and feasibility of delayed intracoronary stem cell therapy in this patient cohort.
In a prospective non-randomized single-center pilot study we enrolled 3 patients with non-ischemic dilated cardiomyopathy (NICM), scheduled for LVAD implantation. In all patients, cell therapy was performed 2 months after LVAD implantation. CD34+ cells were collected from peripheral blood using GCSF stimulation (5mcg bid for 5 days), followed by cytapheresis and immunoselection. Before injection, cells were labeled with a technetium-99m radioisotope to allow for myocardial cell retention quantification 18 hours after cell injection. Suspension of 80 million CD34+ cells was infused in the target coronary artery, using a microcatheter (without balloon vessel occlusion). This is the preliminary report of 3-month follow-up.
All patients were male with an average age of 39.7±13.1 years. A transradial approach was used in all patients and patients were maintained on the VKA with a target INR 1.0

– 2.0 throughout the treatment protocol. All patients received maximal tolerated heart failure GDMT: ARNI/ACEI in 100%, Beta blocker, and MRA in 67%, SGLT2i in 33%, and vericiguat in 67% of patients. One patient received CD34+ cell infusion in RCA and two patients in LAD. At baseline, the average NT-proBNP was 1851±1398 pg/mL, 6'WT 438±39 m, LVEDD 5.4±0.2 and LVESD 4.2±0.2. At the 3-month follow-up we observed a decrease in serum levels of NT-proBNP (-1048 pg/mL), an increase in 6'WT (+71 m), and an improvement of echocardiographic parameters: decrease in LVEDD (-0,67 cm), LVESD (-0,2 cm). In terms of safety, no ventricular rhythm disturbances requiring cardioversion, access site bleeding, VAD thrombosis, or episodes of systemic infection were observed.
In summary, in advanced chronic heart failure patients undergoing LVAD support delayed LVAD-stem cell treatment strategy appears to be feasible and safe, and may, in association with mechanical unloading, promote the reverse remodeling in these patients.

S12 - Intelligent Health Monitoring for Precision Medicine: A Global Perspective

Monday late afternoon
Track B
Jun 10, 16:00 - 18:00

OR-041

Multimodal Biomedical Imaging for the Advance Precision Medicine: Past, Present and Future

Hairong Zheng
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

Over the past two decades, medical imaging has been has played an increasingly critical role in biomedical discovery, diagnosis and treatment of various diseases. The principle of medical imaging is a multidisciplinary science encompassing physics, computer, information and engineering technology, which is a revolutionary technique to capture the complexity of human health and disease across from structural to functional information. Especially, the development of multimodal artificial intelligence models accelerates medical imaging applications in advance precision medicine. However, there still exists challenges in imaging theory, signal processing and image understanding. In this talk, this speech will provide a complete overview of multimodality image techniques more commonly used in health care including magnetic resonance imaging (MRI), computed tomography (CT), positron emission tomography (PET), ultrasound and biomedical optical imaging. Furthermore, the current applications of new biomedical imaging research and clinical areas in the field of brain, oncology, and cardiology impact the way medicine. In the era of artificial intelligence (AI), AI and ML techniques have enormous potential to convert data into a new generation of diagnostic and prognostic models and to drive clinical and biological discovery. This efficient use of imaging information from modalities is shaping the future of medical imaging.

OR-042

United States Perspective on Intelligent Health Monitoring in Precision Medicine

Shankar Krishnan
Past-President, IFMBE, United States

Generally, physicians provide effective care to a patient based on proven responses expected of an average patient from a selected cluster. In the precision medicine approach, care is customized with the medical practices, treatments, processes, and overall decisions designed specifically for the individual patient including factors such as genetics, lifestyles, and environment. Progressive technologies such as artificial intelligence (AI), machine learning (ML), wearable devices, and the Internet of Things (IoT) are applied in intelligent health monitoring for precision medicine to acquire, analyze, and interpret health data in real-time, enabling accurate diagnosis, outcomes prediction, and effective treatment prescription.
Sensors and wearable devices are instrumental in the continuous collection of essential physiological and biochemical parameters, physical activity, and sleep. IoT technology connects wearable devices and sensors to the internet, enabling the seamless transfer of health data to the caregivers, patients, and health information systems ensuring that patient health monitoring is continuous, comprehensive, and accessible from anywhere. AI and ML algorithms analyze huge amounts of data generated by wearable devices to identify patterns, predict health outcomes,

and provide personalized health recommendations.
Continuous monitoring facilitates early detection of anomalies, potentially preventing severe health issues. Data-driven insights enable healthcare providers to tailor treatments to the individual's health profile, improving treatment effectiveness and patient outcomes. Robust encryption, secure data storage solutions, and strict access controls are essential to protect patient information.
Precision medicine is practiced at many medical centers in the U.S.A. Mayo Clinic provides personalized cancer therapy using genomic analysis of tumors. At Cleveland Clinic, AI-powered remote monitoring platforms and genomic information are used to guide the treatment and prevention of heart diseases. Stanford Medical Center uses precision oncology for personalized cancer treatment. Precision medicine is applied at Johns Hopkins for multiple sclerosis, epilepsy, HIV, and TB.
In addition to benefits, intelligent health monitoring for precision medicine also faces challenges concerning data privacy, scalable infrastructure, interoperability, and regulatory frameworks to ensure patient safety, efficacy, and security.
Future developments will focus on integrating advanced AI algorithms for predictive analytics, wearable device accuracy, and patient-centric data platforms to create a proactive system to meet emerging health challenges.
In conclusion, intelligent health monitoring in precision medicine enables personalized, data-driven healthcare by leveraging wearable devices, AI, ML, and IoT, to achieve early detection, personalized treatment, and improved patient outcomes. This approach is employed in the U.S.A. with encouraging results. Intelligent health monitoring will make healthcare more precise, personalized, efficient, and effective in the future globally.

OR-043

Precision medicine and AI for pesonalised estimation of glucose levels via ECG

Leandro Pecchia
Campus Bio Medico University of Rome, Italy, Italy

Despite the advent of modern digital technologies, glucose measures are still mostly based on fingerpick, which is a cumbersome, painful and pollutant disease.
Yet, physiological signals (such as electrocardiogram) can now be acquired continuously from affordable portable wearable devices and deep learning offers unprecedented opportunities for extracting novel information form the same biomedical signals.
In this talk, I will present the results of 5 years of studies developing and validating AI models for real-time non-invasive epidermal and blood glucose estimation, run recruiting about 100 participants (paediatric, adult, older) affected diabetic conditions, and observed in free-living conditions and in a metabolic chamber.
Our results demonstrated that it is possible to detect glycaemic events with sufficient accuracy, specificity and precision, using deep-learning and ECG, minimising the use of fingerpick.

OR-044

Precision medicine in Latin America: Universalizing the promise of innovation

Virgina Laura Ballarin
National University of Mar del Plata, Argentina

Advances toward precision medicine have placed the world on the edge of a true health revolution, where we can provide each individual with a tailored solution. Medicine has always involved caring for people, however, today a series of developments are dramatically increasing doctors' ability to understand the specific factors affecting each patient, enabling much more personalized prevention and treatment plans.
These trends include an increasing ability to collect and store information in an integrated manner, especially in patients' electronic health records, which contain all the data generated by an individual's interactions with a healthcare system, as well as by the individual's own tracking devices; gathering information about the patient also at the molecular level, starting with individuals' genetic profiles, pathogens, and tumors. This, together with increasingly powerful analytical tools of Artificial Intelligence, will enable the diagnosis and treatment as well as the development of personalized medicines at all relevant phases of the clinical development and implementation of new personalized health products.
This transition has only just begun, but there are already significant advances foreshadowing the magnitude of the change that is possible. The greatest progress so far is seen in oncology and the field of rare diseases. Personalized health interventions are increasing in

number and availability in much of the world, including Latin America. However, the challenge in many developing countries will not be supplying precision medicine to those members of the population with significant financial resources, as this is already happening. The challenge will be implementing such innovation through healthcare systems that serve the general population.
As a success story in this regard, there is the agreement between the Ministry of Public Health, represented by the "Dr. Arturo Oñativia" Hospital in the province of Salta, Argentina, and the pharmaceutical company AstraZeneca, aimed at developing accessibility to precision medicine in oncology and other rare diseases.

OR-045

Comparative study of machine learning methods for the early prediction of adherence to treatment

Miguel Rujas[1], ***Beatriz Merino***[1], Peña Arroyo[1], Jim Ingebretsen[2], Jaime Barrio Cortes[3], Ana Isabel Villimar Rodriguez[3], Andrés Castillo[4], Ana Roca-Umbert[2], Francisco Lupiañez[2], Maria Fernanda Cabrera[1], Maria Teresa Arredondo[1], Giuseppe Fico[1]
[1]Universidad Politécnica de Madrid, Spain
[2]PredictBy, Spain
[3]Fundación para la Investigación e Innovación Biosanitaria en Atención Primaria, Spain
[4]Foundation for Research of Hospital Infantil Niño Jesús, Spain

Adherence to treatment is a critical aspect of healthcare with a significant impact on patient outcomes. This has led to the elaboration of several studies over the years to understand adherence better, evolving to the point of applying Machine Learning techniques, whether to study the relationship of different factors with adherence or to make predictions of levels of adherence. However, due to the diversity of techniques, evaluation metrics and adherence measures utilized, no conclusions have been drawn as to which algorithms are best suited to address prediction problems in this domain. This paper aims to apply the three most widely used algorithms in the literature to a database obtained from a primary care centre. The study evaluates the performance of these algorithms with and without applying a feature selection method and with three different adherence measures, using four different evaluation metrics.

OR-046

Bone Metastasis Measurement based on CNN Model for Auto-ROIs

Kang-Ping Lin, Jimmy Hasugian
ChungYuan Christian University, Taiwan

Bone scan imaging (BSI) is the most widely used technique for detecting cancer that has metastasized from its original site, such as breast or prostate cancer. However, some challenging issues have arisen recently, such as how to use AI technology, as well as the latest CNN model, to overcome the necessity for nuclear medicine physicians to perform BSI inspections to examine the regions of interest (ROI) of each skeletal site every time. In addition, changes in brightness information of image dose, abnormal bone shapes or structures, noisy images, and asymmetric gesture positions are all things that AI technology needs to face in practice. There is a high desire to correctly determine image hotspot information in these difficult cases and to make the confirmed ROI information more clinical meaningful. The purpose of this study is to use 1,500 clinical BSI image data to conduct AI technology learning and training, and then verify it with 500 image data. The result is to provide a simple and accurate ROI marker as a prerequisite for clinical application, thereby helping For clinical observation, the total number of metastases measured on conventional bone scan images was analyzed. Experiments on clinical datasets show that the proposed framework is a promising approach with high sensitivity (0.95), specificity (0.94), image content index (0.91), and acceptable accuracy values (0.88).

OR-047

Trusted quality infrastructure federated data space for networks in biomedical engineering and medical diagnostics

Tomasz Sołtysiński
Physikalisch-Technische Bundesanstalt, Germany

Connected ecosystems require to exchange and confirm trust and identity shared automatically among participating federations to establish responsibilities. Such federations are able to point towards each other using secured generally available public communication channels to exchange digital assets, manage the processes, establish interoperable exchange of data and protocols and connecting different stakeholders. It is also the case of networks connecting devices,

institutions and the society, for instance for medical diagnostics.

Such a challenge nowadays, starting from evaluation of devices and technologies up to evaluation of data quality purely deals with measurement of any kind. In this sense, medical diagnostic is nothing but a metrological process securing to provide verifiable verification of performance, to quantify an information content in the data and to guarantee keeping the best possible standards and accuracies. Despite a plethora of different data sources, acquisition methods and quality issues, a precise extraction of real information content from the data, covering the most accurate and adequate representation of the real object or process remains difficult. A proficiency test to validate a method or performance of a participant may be designed to tackle this challenge. The generality of such a tool offers enormous opportunities to compare the skills of a human investigator to a machine implemented, semi- or fully automated approach to gain highest measurements standards.

To solve the problem, a selective disclosure within a quality infrastructure realized by applications of W3C decentralized identifiers (DID) and verifiable credentials (VC) in a federated international data spaces (IDS) approach is proposed. To realize a selective disclosure on demand between federations, a trust and identity work package of the Gaia-X environment has been adapted along with the newly developed Trust mAnagement INfrastructure (TRAIN) concept to facilitate individual trust decisions in a self-sovereign identity (SSI) ecosystem. Such an open-source-based approach, utilizing the tools of Cross Federates Services developed by Gaia-X and the Eclipse Foundation demonstrates a secure, restricted, and interoperable, automated framework to exchange only required information of interest.

The proposed approach is readily scalable, extendable, and accessible to any authorized body and industrial partner. Any legal participant can join Gaia-X ecosystem and use the offered services exposed in a federated catalogue. Through application of SSI based on DIDs, VCs and secured communication, we developed a scenario adaptable to a biomedical engineering endeavor, starting with a use case in a metrology network. Such an approach is easily adaptable to any quality infrastructure, especially considering a potential European Metrology Dataspace and the recently published Quality-X white paper.

Biomedical instrumentation, signal processing and imaging

Monday late afternoon
Track C
Jun 10, 16:00 - 18:15

OR-048

A System for Multimodal Ultrasound Vascular Assessment

Marcin Lewandowski, Piotr Karwat
us4us Ltd., Poland

Ultrasound may be a fast, non-invasive, and easy-to-use tool for vascular assessment and cardiovascular diagnostics. There is an ongoing pursuit of new ultrasound modalities and biomarkers that can achieve this goal.
Our objective is to develop a demonstrator and algorithms for the non-invasive multimodal ultrasound assessment of arteries using a combination of parameters, in particular: pulse wave velocity (PWV), vascular elasticity, and blood flow.
We exploit the software-defined ultrasound paradigm applied on a portable programmable research system to build an integrated system solution.
We propose a fusion of the following methods: ultrafast acquisition, plane wave imaging and Doppler techniques. We hypothesize that the application of these methods at a single site and at the same time will provide new insight into the arterial system. We are currently focusing on two easily accessible sites: the common carotid artery and the radial artery.
We have developed a set of signal processing algorithms tested on datasets collected using three angle plane-wave and ultrafast acquisition (2000 frames/sec). The experimental setup consists of a portable ultrasound research system us4R-lite™ (us4us, Poland) and a linear-array probe Ultrasonix L9-4 (128-element) at the frequency of 6.5 MHz. We acquired in-vivo data on ourselves.
Preliminary verification has shown that the implemented algorithms can track arterial motion on B-mode images and provide input for the estimation of pulse wave velocity (PWV). For the 5-second recording, we captured seven pulse waves for which the average PWV was equal to 4.1 ± 0.3 m/s (mean ±

standard dev.). Therefore, the obtained result is slightly below typical values for healthy adults. The standard deviation, as for such a simple implementation of the local PWV estimation, is reasonably low.
We have demonstrated that the method for measurement of the local PWV can be effectively implemented on the portable research ultrasound scanner. The ultrafast acquisition, access to raw data, and a high-level of programmability will enable us to exploit multimodal approach for vascular assessment.
Our long-term goal is the development of a complete prototype point-of-care ultrasound scanner for vascular examination. It will provide multimodal vascular assessment for clinical research that could lead to the successful monitoring of cardio-vascular biomarkers.

OR-049

Cardiovascular control alterations associated with genetic polymorphisms of proteins involved in sympathetic pathway signal transduction

Michal Javorka, Lenka Matušková, Barbora Czippelova, Jana Čerňanová Krohová, Zuzana Turianiková, Zuzana Kolková, Zora Lasabová
Comenius University in Bratislava, Slovakia

From the family of G protein coupled receptors (GPCRs) involved in the signal transduction, the adrenergic receptors (ARs) mediate the effects of catecholamines. While α-ARs play an important role in the regulation of blood pressure, adenosine A2A receptor exerts potent vasodilatory effects. It is assumed that single nucleotide polymorphisms of proteins involved in signal transduction might influence cardiovascular function. However, the information on their influence on cardiovascular control at rest and under stress in human is still very scarce. We aimed to explore the associations between four selected gene polymorphisms and cardiovascular control related variables in 119 young healthy adolescents at rest and during application of two stressors (orthostasis – head up tilt (HUT) and cognitive load – mental arithmetics (MA)). Subjects were genotyped for α1A-AR (rs1048101), α2A-AR (rs1800544), G protein subunit beta 3 (rs5443) and adenosine A2A receptor (rs5751876) gene polymorphisms. We measured selected cardiovascular parameters, including heart rate, blood pressure, hemodynamic measures – stroke volume (SV), stroke index (SI), cardiac output (CO), cardiac index (CI) and indices related to left ventricular contractility, including systolic time intervals: velocity index (VI), acceleration index (ACI), preejection period (PEP), left ventricular ejection time (LVET), ejection time index (ETI) and flow time corrected (FTc). The spontaneous variability of selected measures was measured in time and frequency domain and baroreflex function was measured employing causal frequency domain method. For statistical analysis of between groups differences, Mann-Whitney U-test was used with Benjamini–Hochberg procedure for multiple testing correction. While α2A-AR polymorphism (rs1800544) was associated with baroreflex control changes during MA only (p=0.010-0.013), HUT demasked the effect of the α1A-AR polymorphism (rs1048101) on vasomotion (vascular resistance variability) (p=0.008-0.027) and cardiac contractile function (SV, SI, LVET, FTc) (p=0.006-0.018). Polymorphism rs5443 in G protein subunit beta 3 was associated with cardiac contractility measures (VI, ACI) (p=0.004-0.035) and reactivity of several systolic time intervals to orthostasis. (p=0.001-0.026) Polymorphism rs5751876 was associated with heart rate and its variability at rest (p=0.001-0.016). Furthermore, this polymorphism influenced vasomotion at rest (p=0.008). Hemodynamic parameters (SV, SI) and contractility measures (VI, LVET) were also associated with this polymorphism. (p=0.002-0.025) We conclude that complex analysis of cardiovascular control can reveal subtle differences in cardiovascular sympathetic nervous control associated with genetic polymorphisms. Perspectively, genotyping of polymorphisms could contribute to risk stratification of patients with cardiovascular disease.

Supported by grant VEGA 1/0283/21.

OR-050

Control Unit for Phototherapy Sources

Jan Havlík, Lenka Maierová
Czech Technical University in Prague, Czech Republic

Bright-light therapy is one of the current techniques for preventing or supporting the treatment of several psychological disorders, such as seasonal affective disorder, bipolar disorder, postnatal depression etc. The paper deals with the design and realization of a control unit for phototherapy sources. General requirements on the control unit are spe-

cified and the principal approach to implement these requirements is described. Three different control unit designs are prepared for three specific devices - a light therapy chamber, a portable phototherapy device and a biodynamic lamp. The goal of the control unit is handling DALI LED controllers, wireless user communication and setting the therapy parameters up.
The unit is realized as a simple embedded system equipped with the ESP-8266 or the WSP32-WROOM-32 microcontrollers. The system implements transmitting DALI commands and receiving the answers from the bus, user communication using the web based Graphical User Interface and therapy control. The specific implementation of the control unit for the phototherapeutic light chamber is described in more detail in the article. The design and implementation of the device were evaluated both in laboratory conditions and in real operation.

OR-051

Transfer Learning from the Domain of Diabetic Retinopathy to Aid in the Detection of Age-Related Macular Degeneration

Roberto Romero-Oraá[1], María Herrero-Tudela[1], Roberto Hornero[2], María I. López[1], María García[1]
[1]University of Valladolid, Spain
[2]Universidad de Valladolid and Centro de Investigación Biomédica en Red en Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN), Spain

Age-related macular degeneration (AMD) is the leading cause of vision loss in the elderly population. Transfer learning has proven useful in fundus image analysis for early diagnosis. Previous models were pre-trained on the ImageNet database. However, a source domain related to retinal diagnosis would facilitate model learning. Our objective was to apply transfer learning from the domain of diabetic retinopathy (DR) to aid in the detection of AMD (binary classification). The proposed model was based on the ResNet-RS architecture. Pre-training aimed at DR diagnosis was conducted using the Kaggle database. Then, fine-tuning was performed using the Automatic Detection challenge on Age-related Macular degeneration (ADAM) dataset. We carried out 3 experiments with different number of images used for fine-tuning. As the main result, our method showed a much faster convergence than the corresponding models pre-trained on ImageNet. Additionally, the proposed source domain was proven especially useful when scarce data in the destination domain was available.

OR-052

Simple electrochemical sensor for measuring oxygen tension in blood or respiratory gases

Tadeusz Pałko, *Kazimierz Pęczalski*
Faculty of Mechatronics, Warsaw University of Technology, Poland

Measurements of the oxygen content in fluids and gases (oximetry) have found many applications in various fields, and are particularly desirable in medicine and environmental protection. The standard method for measuring of oxygen tension, also known as oxygen pressure (pO2) in fluids and gases, including blood and respiratory gases, is the Clark's electrochemical method. The authors have developed and tested a simple electrochemical sensor based on the Clark method for measuring oxygen pressure in blood and respiratory gases. A sensor, developed by us for the assessment of pO2 by the amperometric method, meets the basic metrological requirements for use in direct oxygen tension measurements of blood and respiratory gases.

OR-053

Comparison of forehead and finger photoplethysmographic waveform index for stress assessment

Kristjan Pilt, Ivo Fridolin
Tallinn University of Technology, Estonia

The assessment of acute mental stress is important in daily life for implementing relaxation techniques and preventing mental health conditions. Augmentation index from the finger photoplethysmographic (PPG) signal waveform (PPGAI) has been utilized for stress assessment. However, a reduction in environmental temperature can induce vasoconstriction and decrease skin perfusion, leading to a reduction in finger PPG signal-to-noise ratio. The forehead is relatively insulated from fluctuations in external temperature due to the presence of the skull and scalp. The aim of this study was to determine whether the PPG waveform registered from the forehead could be used instead of the finger for stress assessment using the PPGAI.

The PPG signal was registered from the forehead and finger using reflectance and transmittance mode sensors, respectively, with infrared LEDs. The PPG signals were

registered synchronously and digitized with a 24-bit ADC with a sampling rate of 1kHz.

The PPG signals were recorded while the subject was at rest in a sitting position with eyes open for 4 minutes, followed by a 2-minute long stress test. Stress was induced using either the serial seven, the trail making or the stroop test. The recorded signals were analyzed in MATLAB. Each period of the PPG signals was resampled to a 1-second long segment, and the harmonic components were limited to 6. The forehead and finger PPG waveforms were averaged for rest and stress states, and the PPGAI was calculated.

Signals were recorded from 16 subjects (7 male, 9 female) with an average age of 30.2 years. The PPGAI for the finger and forehead was 0.99±0.148 and 1.34±0.193 for the rest and 1.05±0.157 and 1.43±0.217 for the stress state, respectively. The difference in PPGAI between the rest and stress states was statistically significant for finger (p=0.019) and forehead (p=0.025) using a paired t-test. The Pearson's correlation coefficient between finger and forehead PPGAI was 0.62 (p=0.01) and 0.26 (p=0.32) for the rest and stress states, respectively.

Forehead PPGAI differs between the rest and stress states similarly to the finger. The forehead PPGAI is higher than the finger PPGAI due to the different signal registration sites. The forehead and finger PPGAI are related during the rest state; however, during the stress state, no linear relationship was found. Therefore, the forehead PPGAI could be used for stress assessment, however, it is not interchangeable with the finger PPG signal calculated PPGAI.

OR-054

Non-Invasive Continuous Measurement of the Intra-Abdominal Pressure

Josias Wacker[1], Srdjan Djordjevic[2], Blaž Trotovšek[3], Simon Krašna[4], Jan Žumer[2], Etienne Haenni[1], Grégoire Banderet[1], Patrick Richard[1], Gürkan Yilmaz[1]

[1]Centre Suisse d'Electronique et de Microtechnique CSEM SA, Switzerland

[2]TMG-BMC d.o.o., Slovenia

[3]University Medical Centre Ljubljana, Slovenia

[4]University of Ljubljana - Faculty of Mechanical Engineering, Slovenia

Abdominal compartment syndrome (ACS) is characterized by progressive intra-abdominal organ dysfunction resulting from elevated intra-abdominal pressure (IAP). Measuring the IAP with periodic intervals is essential for timely interven-tion, i.e., for keeping the IAP at normal levels. The current clinical method is in-vasive and offers only intermittent assessments, limiting its effectiveness in con-tinuously monitoring the IAP. Here, we present a continuous multimodal IAP monitoring system (IAP-CMM), which is non-invasive and provides continuous readings. The IAP-CMM device is equipped with bioimpedance measurement (BioZ) and a mechanical muscle contraction force (MC) sensor. Electrical meas-urements are performed via dry electrodes. Following performance and safety verifications, the device was tested on 4 patients who underwent laparoscopic surgery. The preliminary results suggest MC has a high linear relationship with IAP (r=0.99; r2=0.987) and the BioZ exhibits a second order relationship with IAP (r2=0.95). An extensive clinical study recruiting more patients is needed to draw statistically meaningful conclusions.

OR-055

Estimation of middle ear characteristics by an innovative Pressure-Less Acoustic Immittance (PLAI™) device

Francesco Bassi, Agostino Accardo

University of Trieste, Italy

Tympanometry is a gold standard method for the evaluation of hearing function, allowing the identification of pathological alterations of the outer and middle ear by a non-invasive approach. However, in order to make the measurement it is necessary to alter the pressure of the outer ear, which limits the use of the technique for newborns and people with tympanic perforation. To overcome this problem, a complete pressure less technique (PLAI™) was proposed. This paper aims to present the statistically significant correlations between the resonance frequency measured with PLAI™ and the estimated volume and compliance obtained through tympanometry in both healthy subjects and patients affected by Otitis Media with Effusion (OME). The tests, conducted on 57 adult subjects, indicated a significant linear relation between the volume measured with tympanometry and the resonance frequency obtained with PLAI™ that could be used to calculate a value of volume comparable with the gold standard. Moreover, an inversely proportional relation between the compliance from tympanometry

and the resonance frequency from PLAI™ was found, even if affected by several outliers, which hinder a practical use of this specific relation. These two preliminary findings show that it is possible to use this new technique as a preliminary test in subjects deemed to be at risk with tympanometry, eliminating the drawbacks related to the pressure changes but offering a comparable meas-urement of volume and possible future chances of research.

OR-056

Synchronization of magnetocardiographic and electrocardiographic recordings obtained with two separate systems

Kazimierz Pęczalski, Teodor Buchner, Judyta Sobiech, Gerard Cybulski, Tadeusz Pałko
Warsaw University of Technology, Poland

Spatial heterogeneity of cardiac tissue, especially during repolarization phase has long been considered a potential risk factor, related to the probability of life-threatening arrhythmias [1]. However, due to the recent advancement in design of new magnetometers, such as spin exchange relaxation free (SERF), and design of innovative electrodes that are neutral to the magnetic field [2], the sensor fusion approach [3] may embrace a new area of application in cardiological diagnosis. A system was developed to synchronize the parallel electrocardiographic (ECG) and magnetocardiographic (MCG) recordings obtained from two separate measurement systems. The synchronization was based on a manual generation of a marker by the operator. The marker was generated in the MCG system, with software on the LabView platform. Then the marker in digital form, via a USB connection, was subjected to the digital-analog conversion. The value of the analog marker was fed to the low-sensitivity channel of the ECG system. The new system was intended to replace the previous one. In the former version numerical synchronization of recordings was used. Validation of the system was carried out by performing recordings of both signals in a group of volunteers located in the magnetically shielded room (MSR) with an active magnetic compensation. An interesting finding, related to parallel recordings, was the independent occurrence of artifacts in MCG and ECG waveforms, which is caused by the different mechanisms of their formation. Further work should be concentrated on developing the tools for obtaining the diagnostic MCG recordings under clinical conditions, i.e. without a MSR. Such a system should allow to use MCG as a complementary method to the generally used ECG. Wide application of such a system may improve the safety margin for cardiological patients and may reduce the number of sudden cardiac death cases.

[1] Antzelevitch C. Heterogeneity and cardiac arrhythmias: an overview. Heart Rhythm. 4(7):964-972 (2007).
[2] Peczalski K., Sobiech J., Buchner T. et al. Synchronous recording of magnetocardiographic and electrocardiographic signals. Sci Rep 14, 4098 (2024).
[3] Tang Q., Liang J. & Zhu F. A comparative review on multi-modal sensors fusion based on deep learning. Signal Process., 213, 109165 (2023).

S15 - Optimizing Healthcare: Patient-Centered Technology Innovations

Tuesday morning Track A
Jun 11, 10:30 - 12:15

OR-057

Patient-centered Innovation in Hospital Patient Monitoring

Jens Muehlsteff
Philips, Netherlands

Healthcare systems worldwide aim at making care more accessible, convenient, and sustainable. Socio-economic trends, such as the rise in chronic diseases and an increasing number of multi-morbid patients, coupled with staff shortages, require new and enduring technology solutions. These solutions shall enhance the cure and care process for individual patients, guided by the Quadruple Aim. Patient-Centered Innovations in Healthcare represent a paradigm, where rather than a one-size-fits-all approach, these innovations focus on solutions driven by the individual patient needs. This approach considers aspects from a 360° perspective, e.g. including the patient's lifestyle, preferences to tailor therapies, improving measurement accuracy via the inclusion of a patient's specific anatomies or creating supportive care environments for the recovery process considering mental and emotional aspects. In our patient-centered innovation process for new patient monitoring solutions, we begin by thoroughly understanding unmet needs. This understanding serves as

the foundation for outlining solution options, de-risking concepts, and ultimately conducting clinical studies to verify effectiveness. This innovation process is outlined in detail and discussed by examples.

OR-058

Shaping the healthcare of tomorrow through patient-centered digital technologies

Josias Wacker
Centre Suisse d'Electronique et de Microtechnique CSEM SA, Switzerland

For the past few decades, health systems have been challenged by a series of fundamental societal trends, e.g., ageing and an increase of illnesses related to lifestyle, resulting in a continuous increase of health costs. Efficient solutions to these challenges shall be centered on patients' needs and therefore require precise knowledge about the well-being of individuals and groups, i.e., reliable and relevant health data.
With the rise of digital health technologies - based among others on wearable health sensors, ubiquitous mobile internet, and machine data processing - we now have tools at hand which allow us collecting these data in various situations, including individuals' daily lives, and extracting and synthesizing actionable parameters. The resulting devices and systems surpass the state of the art in terms of information content, autonomy, ergonomics, and signal quality.
In this talk we will present how the Swiss Center for Electronics and Microtechnology (CSEM) puts patients at the center of its developments and thereby shapes tomorrow's digital health technologies with groundbreaking innovations such as a multi-signal ambulatory shirt for non-obtrusive functional lung imaging, wearables for cuffless blood pressure monitoring, and algorithms for non-invasive and continuous measurement of the pulmonary arterial pressure. The transformative potential of these developments is anticipated to materialize in reduced healthcare costs, improved quality of life of patients and caregivers, and highly individualized illness prevention.

OR-059

Consensus on best practices for the management of Large-Scale Pilot projects: results from a Delphi study

Davide Piaggio[1], Jordi De Batlle[2], Alba Gallego[3], Gloria Cea[3], Pedro Checa Rifa[1], Alessia Maccaro[1], Giuseppe Fico[3], Leandro Pecchia[1]
[1]University of Warwick, United Kingdom
[2]Institut de Recerca Biomèdica de Lleida, Spain
[3]Universidad Politecnica de Madrid, Spain

The Gatekeeper EU project, funded under the Horizon2020, is a pioneering project aimed at addressing the healthcare challenges associated with Europe's aging population. With an emphasis on digital health solutions, Gatekeeper aims to improve the quality of life for older adults by promoting independence and active aging. Gatekeeper is a large-scale pilot project, encompassing eight pilot implementations across various European regions, serving as crucial testbeds for innovative technologies and services tailored to the needs of older individuals.
Currently, there are no guidelines in literature relative to the management of large-scale pilot projects. For this reason, the large-scale pilot team of Gatekeeper decided to evaluate the lessons learned, and to find consensus beyond the Gatekeeper consortium, involving the other Horizon2020 large-scale pilot projects.
To this purpose, an online Delphi study was organised based on a questionnaire of 18 questions, with some collecting professional information, and others asking the panelists to rank the best practices divided into different themes, namely engagement, intervention, large-scale pilot monitoring and control, planning, recruitment, and other. Borda counting was applied to calculate the overall, while consensus was measured using Kendall's W.
Twenty-eight panelists took part to the Delphi study, and two rounds of the study were enough to reach consensus. This talk will present a list of prioritised best practices for large-scale pilot management.

OR-060

Let's Play a Cognitive Game

Anton Nydal, Ankica Babic
University of Bergen, Norway

This research involved the development of artifacts for testing cognitive decline using a medically validated test, namely "Mini-Cog".

The first artifact was based on literature and design studies that included user feedback. It is a straight-forward test with minimal visual clutter, intended to be used by clinicians. The second artifact was an extension of the first artifact that included gamification elements, such as a narrative, rewards, and Emojis.
The development process involved assessing and comparing relevant development frameworks such as Unity, JavaScript, and SvelteKit. The project necessitated attention to principles of web development, Human Computer Interaction, and international guidelines for technology based cognitive test development and gamification.
The second artifact mirrors old school text-based adventure games, in which players are prompted with situations, and must make decisions. For instance, the simple task of adjusting a clock in the first artifact becomes part of the game narrative when the mayor of a fictional town requests the test taker's character to climb the city hall building to adjust the town clock. Upon accepting and completing this task, the mayor presents their personal pen as a reward. Should the test taker deny the mayor's request, the game provides an alternative narrative which also involves adjusting a clock, and consequently an alternative reward. This allows the test taker to exert agency and collect rewards, while performing the cognitive test.
Development consisted of incremental improvements based on user feed-back from hands on testing. The second artifact was assessed through a Usability Scale (SUS), and a dedicated set of questions for assessing gamifica-tion: perceived engagement, enjoyment, and interest, on numeric scales from 1 to 100.
Preliminary results indicate high system usability.

OR-061

Comparison of automatic and semiautomatic approach for the posterior nipple line calculation

Francesca Angelone[1], Alfonso Maria Ponsiglione[1], Roberto Grassi[2], Francesco Amato[1], Mario Sansone[1]

[1]University of Naples Federico II, Italy

[2]University of Campania 'Luigi Vanvitelli', Italy

Early diagnosis of breast cancer is an important prerequisite for a better prognosis and improved life expectancy.

An accurate diagnosis also depends on the quality of the mammographic image which depends on the correct positioning of the breast during the radiological examination.

From this perspective, automatic tools supporting technologists and radiologists and guiding them in evaluating breast positioning from mammographies can be very useful especially if they can be based on quantitative parameters. However, there is no clear consensus concerning the evaluation of breast positioning from mammographies: several scores have been proposed and commercial software exists with their implementations. In general breast positioning scores take into account a small number of parameters on which a consensus has emerged.

In this study, we compared an automatic and semi-automatic method for calculating the posterior nipple line (PNL), which represents an important quantitative parameter useful for guiding positioning. From the comparison of the automatic method with the semi-automatic method, an excellent agreement emerged in the case of the CC view (ICC = 0.92) and to be improved in the case of the MLO view (ICC = 0.73). This study therefore offers encouraging results for the use of the PNL as a quantitative parameter to guide correct breast positioning.

Biomedical engineering in developing countries

Tuesday morning Track B
Jun 11, 10:30 - 12:00

OR-062

Smartphone Technology: Manual Validation of Two Eye-tracking Algorithms

Wanzi Su[1], Damon Hoad[2], Davide Piaggio[1], Leandro Pecchia[3]

[1]University of Warwick, United Kingdom

[2]South Warwickshire NHS Foundation Trust , United Kingdom

[3]Campus Bio Medico University of Rome, Italy, Italy

Eye movement disorders serve as significant indicators of neurodegenerative diseases, with recent literature exploring their association with long-COVID patients. Novel automated eye feature evaluation methods offer a non-invasive and objective approach to assess neurodegeneration. Leveraging smartphone technology, we aim to develop a personalized toolbox for ophthalmological

and neurological research and eHealth applications.
Our study builds upon previous findings demonstrating the feasibility of using smartphones for pupillometry. A two-phased trial is underway, collecting eye signals from healthy subjects (Phase 1) and neurological disorder patients (Phase 2). Ad-hoc image processing algorithms and artificial intelligence techniques will be used to analyze eye features and evaluate the presence, severity, and progression of neurodegenerative diseases.
In parallel, we developed an eye-tracking algorithm based on smartphone video data, comparing Circular Hough Transform (CHT) with Template Matching (TM). Manual measurements served as ground truth, validating the algorithm's accuracy. Results demonstrate that TM significantly improves the original eye-tracking algorithm, reducing execution time by 79% while maintaining high accuracy. Specifically, TM achieved an average MPE of 0.34% and 0.95% in the x and y directions, respectively, across the nine manually validated videos, outperforming CHT's MPE of 0.81% and 0.85% (although both low error). This advancement holds promise for enhancing eye movement tracking, facilitating early screening and diagnosis of neurodegenerative diseases.
Moreover, our study contributes to the growing body of literature highlighting the benefits of smartphone-based eye-tracking technology. By utilizing the ubiquity and affordability of smartphones, our research overcomes barriers associated with traditional methods and makes sophisticated eye-tracking technology accessible and efficient. Our research paves the way for transformative advancements in healthcare, promising a future where early screening and diagnosis are seamlessly integrated into routine clinical practice. Ultimately, this research has the potential to revolutionize neurodegenerative disease diagnosis and monitoring, ushering in a new era of accessible and efficient healthcare technologies.

OR-063

A Novel University Course on Medical Devices Design and Certification at the University of Siena

Ernesto Iadanza
Department of Medical Biotechnologies, University of Siena, Italy

This paper details the innovative course offered at the University of Siena, focused on Medical Devices Design and Certification. The course integrates key components such as the European Union Medical Devices Regulation (MDR) and practical design strategies tailored for the healthcare sector. Students gain a deep understanding of risk management and the importance of aligning design with the context of use, ensuring devices are both safe and effective. Human factors engineering is emphasized to optimize user-device interaction, while heuristic evaluations and usability tests are leveraged to refine user interfaces. The course also explores the burgeoning realm of Software as a Medical Device (SaMD), emphasizing its increasing significance in healthcare delivery. Sustainable design principles are taught, aiming to equip students with the knowledge to create medical devices suitable for Low and Middle-Income Countries (LMICs), thereby addressing global health disparities. Through project work, students apply their knowledge to design simple medical devices, fostering a blend of innovative thinking and practical skill development. This course prepares students to be industry-ready professionals capable of navigating and contributing to the future landscape of medical device development.

OR-064

Demand for Biomedical Engineers in Tanzania – A View from the Outside

Mirjam Bodenstorfer
UAS Technikum Wien, Austria

We tried to assess the actual demand for biomedical engineers (BMEs) in Tanzania comparing it with the figure of 7,000 BMEs reported by the Tanzanian Minister of Education in 2017. To estimate the present demand and whether existing degree programs would cover it an extensive literature review was conducted. In addition, both a quantitative and a qualitative survey answered by 30 Tanzanian BMEs was analyzed. Local staffing guidelines, the number of registered hospitals and results of the survey were used to further calculate the current staffing requirements considering degree courses offered in this field and the associated number of graduates. Our results show an actual need of at least 2,500 BME graduates which can be covered within 11 years by the existing degree programs. However, it remains open whether the present training courses will meet the demand also in the face

of the actual rapid growth of technologization in the healthcare sector. We conclude that our solidly based results highlight the imperative for further measures in order to enhance the future development of the biomedical engineering sector in Tanzania.

OR-065

The systematic literature review of automated pupillometry system on five common ophthalmological diseases

Wanzi Su[1], Katia Polsi[2], Jacopo Vitale[2], Emmanuel Nathaniel[3], Alvin Vyapooree[1], Daniel Fox[1], Damon Hoad[3], Leandro Pecchia[2], Davide Piaggio[1]
[1]University of Warwick, United Kingdom
[2]Campus Bio-Medico University, Italy
[3]South Warwickshire NHS Foundation Trust, United Kingdom

The pupillary light reflex (PLR) is controlled by the autonomic nervous system. It plays a crucial role in regulating light entering the retina and serves as a potential indicator of neurological and ophthalmological abnormalities. PLR abnormalities have been reported in various medical conditions, including neurodegenerative diseases and acute medical emergencies. The traditional clinical assessment using a pen torch is subjective and may overlook subtle abnormalities, while automated pupillometry offers a more objective and precise method for evaluating PLR. This review aims to explore the applications of automated pupillometry in five common ophthalmological conditions: glaucoma, diabetic retinopathy, macular degeneration, refractive error, and cataracts.
Following the Population, Intervention, Comparison, and Outcome (PICO) criteria and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, a comprehensive search strategy was implemented in SCOPUS. The search string includes keywords related to pupillometry and the five selected eye diseases. Eligible articles written in English and published between 2002 and 2023 were included based on established criteria. Data extraction and quality appraisal were conducted using ad-hoc Excel sheets and the Mixed Methods Appraisal Tool (MMAT), respectively. The narrative synthesis method was used to summarize findings from different study designs.
Studies in the literature have investigated pupillary responses to light stimuli and evaluated variables such as baseline pupil diameter, constriction velocity, and latency as potential biomarkers for disease detection and monitoring. The systematic literature review identified 50 relevant studies out of 1118 items, with glaucoma being the most studied condition (25 papers), followed by diabetic retinopathy (10 papers), refractive error (6 papers), macular degeneration (7 papers), and cataracts (2 papers). Quality appraisal categorized studies as good (42%), fair (50%), or poor (8%), which indicates the need for cautious interpretation. Glaucoma received the most attention, with consistent findings of reduced constriction amplitude and prolonged duration in affected patients. Diabetic retinopathy studies highlighted impaired pupillary function. Macular degeneration research showed decreased constriction amplitude and velocity. Refractive error papers presented different responses influenced by stimulus type and severity. Cataract studies revealed reduced pupillary constriction associated with severity and age-related changes.
Stimulus technologies demonstrate diversity, including LCD screens and Maxwellian view optical systems, each offering unique advantages. Pupillometer technologies involve manual and automated devices such as NeurOptics' NPi, providing objective measurements. Infrared cameras were widely used for precise image capture. Quality appraisal emphasized the importance of considering confounders and sample size limitations, encouraging data sharing for future research.

OR-066

A frugal smart tool for screening for diabetic neuropathies

Davide Piaggio[1], Rossana Castaldo[1], Gianluca Garibizzo[2], Ernesto Iadanza[3], Leandro Pecchia[1]
[1]University of Warwick, United Kingdom
[2]Independent researcher, Italy
[3]University of Siena, Italy

Diabetic neuropathy, a nerve damage linked to diabetes mellitus, poses significant risks of disability, morbidity, and mortality if not promptly diagnosed. It presents a considerable economic burden and is increasingly prevalent in sub-Saharan Africa, affecting up to 61% of diabetic individuals. Recognizing the urgency, the United Nations has prioritized reducing diabetes-related mortality in its Sustainable Development Agenda. While existing solutions for diabetic management primarily focus on lifestyle adjustments and glycemia monitoring, the screening for diabetic neuropathies, particularly in the realm of digital

health, remains limited. Cutting-edge screening methods are resource-intensive and time-consuming, whereas traditional approaches are effective but require specialized knowledge often lacking in low-resource settings. These settings, especially in low-income countries, struggle with limited expertise, financial resources, and access to medical supplies, compounded by challenging environmental conditions that impede the safe deployment of medical devices.

To address these challenges, this paper proposes a smart screening tool for diabetic neuropathies, integrating three established methods with 3D-printed accessories and a smartphone app. This innovative approach aligns with the UN's Sustainable Development Goal 3 and advances the fourth industrial revolution in healthcare. Additionally, an ongoing on-field evaluation of this smart tool involves a pilot study with 11 normosubjects. Preliminary results suggest its potential as a viable solution to enhance the standard of diabetic care, particularly in diabetic neuropathy screening, on both a global scale and within resource-constrained settings.

OR-067

Establishment of Femoral Bone Defect Model in Sprague-Dawley Rat for Engineered Scaffold Implantation: A Pilot Study

Amira Raudhah Abdullah, Intan Maslina Musa
Department of Basic Medical science I, Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia (USIM), Malaysia

Animal models undeniably offer advantages for studying bone regeneration in bone tissue engineering. Currently, a lack of documented and standardized critical size defects (CSD) protocol exists for femoral bone. This study established a femoral bone rat model to evaluate engineered scaffold and its effect on bone regeneration. Eight Sprague-Dawley rats were divided into four groups, each induced with specific sizes of circular femoral defects: 1.5 mm diameter; 4.0 mm depth (Groups A and B), and 2.4 mm diameter; 7.0 mm depth (Groups C and D). Rats were euthanized at 4- and 8-weeks post-induction. Observations revealed that the 4-week period was insufficient for initiating the bone healing process. Notable signs of bone healing and remodelling become apparent only after 8 weeks with normal morbidity scoring at week 5 onwards. Gross examination indicated that rat models with a defect size of 1.5 mm diameter; and 4.0 mm depth healed at a faster rate suggesting inadequate defect size. In contrast, the rat model 2.4 mm diameter; and 7.0 mm depth defect emerged as the suitable model with evidence of newly formed bone signifying the process of mineralization at the defect site. The Hematoxylin and Eosin (H&E) staining of bone tissue demonstrates substantial formation of bone tissues (osteoid) and vascularized areas, consequently supporting the efficacy of this model. Therefore, this study finds that the 8-week timepoint with a 2.4 mm diameter and 7.0 mm circular defect is ideal for assessing bone regeneration of an engineered scaffold in rat bone model.

S17 - Regulatory Learning

Tuesday morning Track C
Jun 11, 10:30 - 12:00

OR-068

Living Labs as Regulatory Learning Tools for Biomedical Engineering and Digital Transformation in Healthcare

Giuseppe Fico
Universidad Politécnica de Madrid, Spain

In this talk, we delve into the paradigm of open innovation, focusing particularly on the concept of Living Labs as experimental environments fostering collaborative learning across various stakeholders. Drawing inspiration from the framework of the quintple helix, we explore how Living Labs serve as hubs for tackling complex, industry-specific challenges while engaging with stakeholders from government, academia, industry, civil society and the environment.

In the context of this decade's regulatory landscape, marked by the adoption of landmark policies such as the General Data Protection Regulation (GDPR), the impending European Health Data Space regulation, the AI Act, the Health Technology Assessment (HTA) regulation, and the Medical Device Regulation (MDR), new opportunities emerge alongside challenges. These regulatory developments underscore the imperative for the biomedical engineering community to actively contribute to the creation of secure and protected environments conducive to sustainable growth within the European healthcare sector.

As we navigate this evolving regulatory landscape, it becomes increasingly clear that col-

laborative efforts and innovative approaches are essential for fostering responsible innovation and addressing emerging challenges effectively. Biomedical engineering education plays a pivotal role in equipping future professionals with the knowledge, skills, and ethical frameworks necessary to navigate these complexities and drive positive change within the healthcare ecosystem.
Through initiatives such as regulatory experimentation and the integration of real-world case studies into curricula, we can empower BME to become proactive agents of change, capable of addressing regulatory challenges with creativity and ingenuity. Moreover, leveraging the infrastructure of Living Labs, we can create immersive learning experiences that bridge the gap between theory and practice, enabling BME to gain firsthand insights into the complexities of regulatory compliance and ethical decision-making.
In conclusion, the convergence of open innovation principles, regulatory dynamics, and educational initiatives presents a unique opportunity for the biomedical engineering community to shape the future of healthcare innovation in Europe. By embracing collaboration, innovation, and a commitment to ethical practice, we can build a more resilient and sustainable healthcare ecosystem that meets the needs of society while fostering economic growth and technological advancement.

OR-069

Integrating Living Labs for Harmonized Data Collection in Transitional Care

Beatriz Merino, Gloria Cea, Ivana Lombroni, Irene Mallo, Diego Carvajal, Alejandro Medrano, Maria Fernanda Cabrera, ***Maria Teresa Arredondo***, Giuseppe Fico
Universidad Politecnica de Madrid, Spain

The concept of transitional care has become increasingly critical as the demographic landscape shifts towards an aging population, along with the rising prevalence of chronic diseases across all age groups. Various studies in the sector have shown that data on patient mobility and functional status can predict successful transitions and reduce the risk of adverse events. Collection of data from clinical and patient-reported outcome measures may support better decisions during care transitions. However, there is no harmonized way to combine this information or to exploit it in these contexts.

Living Labs emerge as innovative ecosystems and infrastructures enabling real-world testing and develop-ment of new technologies and approaches.

Within the context of the H2020 VITALISE project funded by the European Commission Living Lab infrastructures have been used to support research infrastructures and remote digital access to datasets (virtual access) of rehabilitation, transitional care and activities of daily living through har-monized processes and common tools.

The LifeSpace at Universidad Politécnica de Madrid has been used as a controlled laboratory-like environment for the generation of new knowledge and the creation of new innovative products and services especially in the field of transitional care.

OR-070

Bridging Digital Transformation through EU-LAC Cooperation

Maria Fernanda Cabrera
Universidad Politécnica de Madrid, Spain

The SPIDER project aims at harnessing the unexploited potential of the newly established BELLA network, thereby facilitating the realization of Europe - Latin America and the Caribbean (EU-LAC) dialogues' outcomes in the digitalisation and Research & Innovation (R&I) sectors. This initiative is in line with the European Union's commitment to prioritize digital cooperation within its relationship with LAC, with the goal of mutual economic advancement through new technologies, innovation, and digitalization.
The longstanding tradition of EU-LAC cooperation on digital transformation led to the design and deployment of the interconnectivity infrastructure between both regions in the framework of BELLA Programme. Under the leadership of RedCLARA and GEANT, BELLA supported the construction of a submarine fibre-optic cable linking Lisbon (Portugal) with Fortaleza (Brazil) as well as an onward terrestrial connection with several countries in the region. More recently, the ongoing BELLA II project seeks to expand the digital ecosystem to new countries, especially in Central America and the Caribbean, enabling relations and exchanges between companies, research centres, educational institutions and national research and education networks. Nevertheless, despite the high-capacity data connection and long-term interconnectivity between European and Latin American R&I communit-

ies, the full potential of the BELLA network has not been exploited so far. Consequently, the potential for EU-LAC cooperation on digital transformation is hindered, which is having a negative impact on the economic and social development of many countries in the LAC region. Recent years have seen the initiation of various digital dialogues between the EU and key LAC partners like Brazil, Mexico, and Argentina, and agreements with the Pacific Alliance to enhance R&I cooperation. The EU-LAC Digital Alliance, inaugurated in March 2023, marks the first regional digital partnership advocating for a human-centered digital transformation. Nevertheless, a significant divide between the political commitments made during these dialogues and their effective execution persists, undermining the expansion of digital cooperation in R&I.
SPIDER proposes to bridge this gap by providing a structured framework to translate political agreements into actionable strategies at bilateral, regional, and multilateral levels, while also engaging stakeholders comprehensively. By aligning digital dialogue commitments with national policies and strategies, SPIDER intends to lay the groundwork for implementing dialogue outcomes throughout the BELLA countries in LAC, thus enhancing EU-LAC cooperation in digital transformation and R&I for sustained economic and social progress.

OR-071

Regulatory Frameworks and Validation Strategies for Advancing Artificial Intelligence in Healthcare

Laura Lopez-Perez[1], Beatriz Merino[1], Miguel Rujas[1], Alessia Maccaro[2], Leandro Pecchia[2], ***Sergio Guillen***[3], Maria Fernanda Cabrera[1], Maria Teresa Arredondo[1], Giuseppe Fico[1]

[1]Universidad Politécnica de Madrid, Spain

[2]University of Warwick, United Kingdom

[3]ACTIVAGE Association, Spain, Spain

As AI technologies progress rapidly, there is an increasing need for tailored regulations that effectively address data provision, sharing, utiliza-tion, and knowledge generation. This paper delves into the essential regulations and emphasizes the crucial role of AI model validation in guaranteeing the dependability and effectiveness of AI-driven solutions. An innovative approach is introduced, detailing an organized four-phase methodology for external validation. The integration of these frameworks and the implementation of a DataLab are deemed imperative for fostering transparency, ac-countability, and enhancing patient outcomes within the swiftly evolving landscape of AI in healthcare. Through a comprehensive examination of key regulations and a structured validation approach, this research underscores the critical need for meticulous scrutiny and validation of AI models to en-sure their reliability and efficacy in improving healthcare delivery. This study aims to lay the foundation for further exploration and advancement in this pivotal area, offering a roadmap for stakeholders, researchers, and poli-cymakers to navigate the complexities of AI integration in healthcare while prioritizing patient safety and quality of care. The work has been done in the framework of the GATEKEEPER project, funded by the European Commis-sion under the Horizon 2020 program.

OR-072

The BEAMER Lab: conceptualizing a living lab frame-work to develop predictive models, tools, and support programs to improve adherence to treatment

Beatriz Merino[1], Miguel Rujas[1], Peña Arroyo[1], Rodrigo Martín Gómez del Moral Herran[1], Jim Ingebretsen[2], Francisco Lupiañez[2], Giuseppe Fico[1]

[1]Universidad Politécnica de Madrid, Spain

[2]PredictBy, Spain

This study introduces the BEAMER living lab for the aggregation of data, scenarios, and ecosystems to improve adherence to medical treat-ments. Recognizing the complexity of adherence behaviours across different health conditions, the living lab environment enables 1) the management of real-world data, 2) the definition and simulation of real-world scenarios, and 3) the implementation of real-world solutions where an intervention to ad-dress adherence is introduced. The framework may have potential in bridging the gap between theoretical research and real practice, offering a scalable so-lution to improve health outcomes by optimizing adherence to treatment. The work has been carried out as part of the activities of the BEAMER pro-ject funded through the Innovative Medicines Initiative 2 Joint Undertaking under grant agreement No 101034369.

S08 - Electroporation meets cardiac treatment

Tuesday afternoon Track A
Jun 11, 14:15 - 15:30

OR-073

Modelling Dilated Cardiomyopathy through Induced Pluripotent Stem Cell-Derived Cardiomyocytes

Rebecca Artioli[1], Rossella Cannilla[1], Cecilia Thairi[2], Matteo Dal Ferro[3], Elisa Di Pasquale[2], Gianfranco Sinagra[3], Mauro Giacca[4], Chiara Collesi[3]

[1]International Centre for Genetic Engineering and Biotechnology (ICGEB), Italy

[2]Humanitas Clinical and Research Center-IRCCS, Italy

[3]University of Trieste, Italy

[4]King's College London, United Kingdom

Non-ischemic dilated cardiomyopathy (DCM) is the leading cause of progressive cardiac failure, arrhythmia and sudden death. Dominant truncating mutations of the sarcomeric protein titin [TTN-truncating variants (TTNtvs)] are the most common genetic cause of DCM, occurring in approx. 20% of familial or sporadic cases. Titin, the largest human protein, is an essential component of the sarcomere, providing most of the passive strenght and modulating the active contractile force in striated muscles. TTNtvs have been identified in each protein segment, but TTNtvs in DCM patients are markedly enriched in the A band.

Human induced pluripotent stem cell-derived cardiomyocytes (hiPSC-CMs), together with Engineered Heart Tissues (EHTs), offer new promising approaches for cardiac disease modeling and mechanistic investigation.

In this project, we successfully generated functional cardiomyocytes from hiPSCs, derived both from healthy donors and two TTNtv patients (TTNTS_3 and TTNTS_5), selected from of the Heart Muscle Disease Registry of Trieste, bearing the c57847+4delGTAA and c.69783G>A mutations respectively.

In order to investigate the molecular signature of the TTNtv variants, we biochemically dissected the molecular anatomy of each variant by an optimized Western Blot approach, using Titin-specific antibodies matching different regions of the protein. Of note, the protocol will allow to identify specific intracellular transducers, enabling to characterize at a molecular level the specific intracellular signaling cascade for each protein isoform. Major alterations in the contractile apparatus were highlighted by immuno-fluorescence staining of selected sarcomeric proteins. Major differences in proliferation between healthy and TTNtv hiPSC-CMs were detected by Edu incorporation, consistent with the differential activation of YAP and NOTCH pathways, revealed by AAV6- based fluorescent reporters. Moreover, the contractile phenotype of patient-derived hiPSC-CMs was characterized using fibrin-based engineered heart tissues (EHTs), an in vitro model of an auxotonic contractile syncytium.

Collectively, our in vitro evidences, arising from a combined biological, biochemical and electrophysiological approach, revealed, in hiPSC-CMs bearing specific mutations in the Titin protein, structural alterations of the contractile apparatus and the intracellular biochemical machinery, possibly enabling the dissection of the molecular mechanisms leading to the clinical phenotype, in view of a patient-tailored translational approach.

OR-074

Exploring the Effects of Electroporation on Primary Rat Ventricular Cardiomyocytes: Insights into Action Potential, Calcium Release, and Contraction Dynamics

Vid Jan, Marko Stručić, Tina Turk, Jernej Jurič, Monika Kos, Matej Reberšek, Martina Perše, Lea Rems, Damijan Miklavčič

University of Ljubljana, Slovenia

Atrial fibrillation (AF) is the most common cardiac arrhythmia that poses a significant challenge in clinical practice. It is estimated that 1 in 4 adults above the age of 40 will experience a form of AF. Catheter ablation that isolates pulmonary veins from heart tissue, stands as a primary treatment for paroxysmal AF. Pulsed Field Ablation (PFA) emerges as a promising new ablative approach that utilizes irreversible electroporation to cut off electric triggers within pulmonary veins from entering heart tissue and thus enables heart to beat normally again. Even though PFA was proven to be comparably effective and safer than conventional thermal ablation methods, questions persist regarding its cellular impact and the recurrence of arrhythmias post-procedure.

In normal physiological conditions, heart muscle contraction is headed by Ca2+ release, caused by an action potential. In this study, we delve into the cellular responses of primary

rat ventricular cardiomyocytes to electroporation. Through optical electrophysiology, we investigate the effects of different pulse parameters on action potentials (AP), calcium transients (CaT), and sarcomere shortenings (SS). When cells were exposed to regular electrostimulation that mimicked physiological pacing all three signals were appropriately synchronized and consistent in amplitudes and dynamics. Afterwards, cells were subjected to either eight 100 μs pulses (monopolar), eight bursts of 25 x 2 μs pulses (bipolar) with interphase and interpulse delays of 2 μs, or eight bursts of 40 x 200 ns pulses (monopolar) with interpulse delay of 100 μs. Bursts and 100 s pulses were applied at a frequency of 1 Hz. With all three evaluated protocols we noticed an uncoupling of AP-CaT-SS with pulses that were below the lethal threshold. When we exposed cells to 100 μs monopolar pulses, uncoupling was attained at lower electric fields in cells that were oriented parallel to electric field, compared to those oriented perpendicularly. For cells exposed to either 2 μs bipolar or 200 ns monopolar pulses the opposite was true.
Interestingly, our results demonstrate that even in the absence of action potentials, contractions can occur due to uncoupling, suggesting an alternative pathway for calcium ion entry. We further elucidate these effects using the Luo-Rudy model, highlighting the increased sarcolemma conductivity induced by supraphysiological electric pulses. These insights into the cellular dynamics following electroporation shed light on the complexities underlying PFA procedures and underscore the importance of considering contraction dynamics beyond intracardiac electrogram disappearance.

OR-075

Excitation and electroporation in excitable S-HEK cells exposed to electric pulses of different durations

Tina Batista Napotnik, Tina Cimperman, Lea Rems
University of Ljubljana, Slovenia

Electroporation is used in many medical treatments. Some of them are used for treating excitable tissues (nerve, muscle, cardiac), such as cardiac pulsed field ablation for treating heart arrhythmias, brain tumour ablation based on irreversible electroporation, and nucleic acid delivery into muscle tissue for gene therapy. Electroporation alters the electrophysiological response of excitable cells in a complex way. During medical treatments, even non-targeted cells can be affected. Therefore, it is important to better understand the underlying mechanisms of electroporation and electrostimulation.
Electroporation-based treatments use electric pulses of different pulse parameters (amplitude, duration, number, repetition rate). Therefore, we studied the effect of electric pulses of different durations on excitability and electroporation of excitable cells in vitro. As a model, we used genetically engineered S-HEK cells that express sodium and potassium channels, a minimal complement needed for excitability of otherwise non-excitable HEK cells. We exposed S-HEK cells grown in monolayers to electric pulses of 500 ns, 1 s, 10 s and 100 s and optically monitored transmembrane voltage (TMV) with a potentiometric dye ElectroFluor630 under a fluorescence microscope. We were able to trigger single or multiple action potentials in cells with pulses of all selected durations, however, the shape of action potential became affected by pulse duration. At lower electric fields we detected a delay between the pulse exposure and the occurrence of the action potential, which was significantly longer after the shortest (500 ns) pulse delivery compared to 100 s pulse delivery. At higher electric fields, we achieved a prolonged depolarization which we consider a hallmark of electroporation. By monitoring intracellular calcium using the Fura-2 dye, we also observed a complex calcium response for all pulse durations. These results provide a useful basis for developing theoretical models describing the complex interplay between excitability and electroporation.

OR-076

Localized electroporation on a chip for effective DNA electrotransfer

Pouyan Boukany
Department of Chemical Engineering, Delft University of Technology, Netherlands

The electrotransfer of nucleic acids and proteins has become a pivotal aspect of biotechnology, especially in gene modification and genome editing applications. Traditional bulk electroporation methods face significant limitations in delivering precise amounts of genetic cargo into living cells without compromising cell viability during electric pulse administration. We have developed a localized single-

cell electroporation chip designed to deliver exogenous biomolecules with exceptional efficiency while preserving high cell viability. Our microfluidic device employs a microtrap array to immobilize cells via flow, followed by the introduction of target molecules for electrotransfer to the cells under electric pulses. This system allows real-time monitoring of exogenous biomolecule electrotransfer. Our numerical simulations confirm that localized electroporation is the primary mechanism of permeabilization in the microtrap array electroporation device. We demonstrate the simplicity and accuracy of this microtrap technology for electroporation by delivering both small molecules using propidium iodide and large molecules using plasmid DNA for gene expression. This showcases the immense potential of this minimally invasive method for precise intracellular delivery, applicable across various domains from bioprocess engineering to therapeutic applications.

OR-077

Gene electrotransfer into cells in hydrogels as extracellular mimicry

Saša Haberl Meglič
University of Ljubljana, Slovenia

Gene electrotransfer (GET) enables the transfer of DNA into cells using electric pulses. The efficiency in in vivo, where there is a dense extracellular matrix, is usually low due to the relatively low diffusion and electrophoretic mobility of DNA.
In order to unravel GET mechanisms and limit the number of animals used for transfection studies, the use of different 3D cell models has been proposed: (i) different cells embedded in an allograft, in a self-secreted extracellular matrix, in a barium alginate membrane, in a hyaluronic acid-based matrix or in a collagen hydrogel; and (iii) different cancer entities aggregated in multicellular spheroids.
Many parameters were investigated, such as: (i) different DNA sizes, where smaller DNA was transfected with higher efficiency; (ii) different DNA concentrations, where transfection efficiency increases with DNA concentration up to a certain point; (iii) different mode of DNA application (application of the DNA to the 3D model or injection into the 3D model to mimic the in vivo experiment where the DNA is injected into the tissue); (iv) different pulse conditions (pulse strength, pulse number, HV LV pulses...), where the GET efficiency in the 3D cell model depended on the pulse protocols; and (v) different electrode configurations (plate or needle electrodes with various arrays).
Common to all 3D models was that successful GET could only be ascertained on the surface of the 3D constructs, indicating that DNA diffusion is impaired in the 3D cell model. In addition, expression was only detected in a cap of the spheroids facing the cathode, showing that the negatively charged DNA moves towards the positive electrode in the electric field.
For our study, we built a 3D cell model (CHO cells embedded in a collagen matrix) in which we investigated different DNA applications and different pulse parameters. The GET efficiency was higher when the DNA was injected into the 3D cell model, showing that the DNA has impaired diffusion in the 3D cell environment. Therefore, it is important that the DNA is injected in a dense extracellular matrix (e.g. in tissue) at multiple sites to achieve an appropriate local DNA concentration that enables efficient GET. We have also shown that GET efficiency in the 3D cell model depends on pulse protocols and that electrophoretic mobility of DNA is impaired in 3D.

S27 - Perspectives of BME Education

Tuesday afternoon Track B
Jun 11, 14:15 - 15:30

OR-078

IFMBE project on Survey of BME Programs worldwide by IFMBE regions

Ratko Magjarević
University of Zagreb, Croatia

The session is aimed to facilitate exchange of academic and professional experiences of a group of invited panelists in the field of Biomedical Engineering and Bioengineering. IFMBE distinguished academics will present their diverse perspectives of the future of development of biomedical engineering education. Professor from IFMBE affiliated BME societies will be invited to participate in this session.

OR-079

How the BME study programs survey is planned to be organized: A proposal

Nicolas Pallikarakis
Institute of Biomedical Technology (INBIT), Greece

The approach for the new Global Survey on Biomedical Engineering (BME) studies that are offered today worldwide, is proposed to be based on previous experience of similar surveys performed in the past in Europe, taking also advantage of new internet data searching tools. The initial step should be to achieve involvement of the IFBME member national societies, as well as the regional and international organizations. An international project steering committee should be established with a priority to decide on the criteria/requirements that BME educational programs should fulfil in order to be included in the BME survey. Given the variety of the programs that are appearing under a BME umbrella, this is a critical issue. A second task is to reach an agreement on the way the information should be collected. The collaboration of regional and national societies is very important in performing this work. Commonly accepted approaches are critical in this procedure to avoid heterogeneity of results. A detailed guide should be prepared and explained to the participants that will perform information collection.

Verification through internet searches should be the next step for the final inclusion of the BME programs meeting the criteria to the survey list. Universities should then be informed and asked to provide their comments and potentially their agreement to appear on the list. A management committee should be responsible for the whole project and a coordinating organization should be assigned for the overall project management. A more precise plan will be deployed during the first phase of the project.

OR-080

Emerging Technologies to Support Health Care and Independent Living Summer School: An Innovation Education Model in Latin America

Martha L. Zequera[1], Ratko Magjarević[2], Virginia Ballarin[3], Luis Zamudio[4], Shankar Krishnan[5], Juan Pastore[3], Eduardo Pinos[6], Rosa Flores-Luna[7], Alvaro Poveda[8], Piotr Ładyżyński[9], Nubia Arroyo[10], Mauricio Cubides[1]

[1]Pontificia Universidad Javeriana, Colombia
[2]University of Zagreb, Croatia
[3]Universidad Nacional de Mar del Plata, Argentina
[4]Instituto Politecnica Nacional - CITEDI, Mexico
[5]Past-President, IFMBE, United States
[6]Universidad Politécnica Salesiana, Ecuador
[7]Universidad Nacional Autónoma de México (UNAM), Mexico
[8]Human Assistive Technologies, Mexico
[9]Nalecz Institute of Biocybernetics and Biomedical Engineering Polish Academy of Sciences, Poland
[10]Universidad de la Salle, Colombia

The Summer School model was organized by the Department of Electronics at Pontificia Universidad Javeriana in Bogotá, Colombia, in collaboration with IFMBE, CORAL, ABIOIN, and technical support from IEEE/EMBS, has emerged as a transformative force in Biomedical Engineering education since its inception in 2017. Drawing over 300 participants across 13 countries in Latin America, including Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Honduras, Guatemala, Mexico, Peru, and Panama, the program is committed to leveraging emerging technologies to enhance the quality of life for the elderly population.

The Summer School cultivates a collaborative environment, emphasizing interdisciplinary teamwork through various activities such as plenary lectures, seminars, workshops, living labs, technical industry meetings, and a Hackathon Challenge. These activities were meticulously designed to develop soft skills like collaborative work, creativity, decision-making, and communication, which are essential for effectively addressing healthcare challenges.

Central to Biomedical Engineering is the resolution of healthcare issues through user-centered solutions, particularly in addressing the needs of vulnerable populations like the elderly. Thus, the program fosters an interdisciplinary and sustainable approach, incorporating frameworks like design thinking and scrum to promote critical thinking and empathy among participants. The Summer School significantly enhances technical knowledge through its emphasis on digital transformation.

Beyond academic pursuits, the Summer School serves as a platform for cultural exchange and networking opportunities, creating a collaborative platform for participants from diverse backgrounds. This inclusive environment encourages the exchange of experiences and ideas between countries, academia, industry, and international organizations, with the goal of developing innovative technological solutions for the elderly.

The Summer School model exemplifies an

approach to Biomedical Engineering education, blending technical training with soft skill development and cultural exchange. By fostering collaboration and innovation, the program equips participants with the tools and mindset needed to address healthcare challenges and create a meaningful impact on society.

OR-081

What does harmonization bring to students, teachers, and researchers in BME

Shankar Krishnan
Past-President, IFMBE, United States

Harmonization is defined in different ways: "the act of making different people, plans, situations, etc., suitable for each other"; "the act of making systems or laws similar in different companies, countries, etc. so that they can work together more easily; the act or process of producing a pleasing visual combination. Harmonization in higher education may be considered to be, "a process to ensure horizontal and vertical articulation between programs and institutions among various higher education systems."

Biomedical Engineering (BME) is the fusion of physical, mathematical, and life sciences with multiple engineering disciplines to solve intricate problems in medicine and biology. In the complex interdisciplinary BME field, harmonization plays a catalytic role in navigating the students, faculty, and researchers to reach new horizons of understanding, innovation, understanding, and cooperation. Harmonization fosters an environment facilitating collaborative efforts applying common standards and accepted practices with a seamless flow of knowledge to thrive and succeed. While harmonization offers meaningful benefits for students, teachers, and researchers, multiple challenges are encountered in its implementation and realization phases, especially in BME. Experienced academics will agree with the difficulties involved in the harmonization of curriculum, credits for transfer/substitution/advanced placement, distribution of academic credits, lab/project/research/internship work to meet the graduation requirements, and accreditation criteria of the program by the appropriate agencies. The cited factors are essential for harmonization at the undergraduate level. Harmonizing the coursework and research at the master's and doctoral levels at the national and international levels poses additional hurdles. However, harmonization will yield realizable benefits to the BME students, faculty, and researchers.

The major advantages of harmonization for students include increased mobility, enhanced recognition of qualifications, and exposure to diverse approaches. For faculty, harmonization contributes to the streamlined curriculum, shared standards, and learning outcomes providing a framework for new course developments, reducing redundancy, and promoting consistency. The major advantages of harmonization for the researchers include faster research progress, faster development of new medical technologies, greater comparability to new findings leading to more robust scientific conclusions, enhanced national and international collaborations, and access to a wider pool of knowledge and resources.

In conclusion, harmonization creates a more cohesive global landscape for BME education and research. By streamlining processes, supporting collaboration, and ensuring quality, harmonization empowers students, teachers, and researchers to advance the BME field to improve healthcare solutions globally.

OR-082

BME educational programs - Between historical foundations and the need for interdisciplinarity

Damijan Miklavčič
University of Ljubljana, Slovenia

The development and rise of Biomedical Engineering and growing MedTech Industry has resulted in need to educate professionals to support and provide further the development of ever more complex and diversified "biomedical engineering". But also, to enable use of complex devices and systems in hospitals and at home. Heath care professionals and supporting professions like clinical engineers and medical physicists, are involved and responsible for operation of these devices, quality control and safety.

There were several attempts in Europe and USA to define (essential components) of Biomedical engineering curriculum. Several European projects (many lead by Nicolas Pallikarakis) provided guidelines and made and effort to define the minimum course including course material for BME 1st and 2nd degree according to Bologna structure of higher education

implemented in Europe. Similarly, efforts supported by Whitaker foundation, which has enabled growth and development of Biomedical Engineering Educational programs through out of USA, lead to several exercises in developing common curriculum.
It soon became obvious that some programs grew from chemistry, some from electronics/electrical engineering and some from mechanical engineering – depending on the history, local environment and strength and background of key faculty members. There is no unified or commonly accepted curriculum of Biomedical engineering. At the same time, we have to admit that graduates from BME programs are well received even outside narrow professions – mainly because of their interdisciplinary knowledge and ability to work with other professions. Perhaps the profession and area of Biomedical Engineering still needs to mature, or the essence of Biomedical Engineering is interdisciplinarity. Before we become a discipline, we are not well defined. Is this good or not is something that remains to be seen.

S16 - Out-of-the-lab dry EEG

Tuesday afternoon Track C
Jun 11, 14:15 - 15:30

OR-083

Dry electrode technologies for comfortable and reliable out-of-the-lab EEG

Patrique Fiedler[1], Abdumumin Olimzoda[1], Indhika Warsito[1], Silvia Comani[2], Jens Haueisen[1]
[1]Technical University of Ilmenau, Germany
[2]University G. d'Annunzio of Chieti-Pescara, Italy

Dry electrode technologies have enabled new fields of application for electrophysiological measurements, specifically EEG. In contrast to conventional gold-standard gel-based electrodes, dry electrodes directly contact the scalp of the user through the hair layer, without the need for electrolyte gels or pastes between electrode and skin. The dry application principle reduces preparation effort, complexity and the need for specially trained medical personal. No preliminary skin gelling or subsequent cleaning is required and there is no risk for gel-bridges between adjacent electrodes, especially in high-density setups.
We present an overview of our recently proposed novel dry Multipin and Flower electrodes. We discuss the differences between both dry electrode concepts and present validation results in different application contexts and metrics: comparison between gel-based and Multipin dry recordings as well as between Multipin and Flower dry electrodes using different signal quality metrics in time, frequency and spatial domain; comparison of application time and wearing comfort; reproducibility in a multi-center study; impact of operator training; interrelation of electrode-skin impedance and channel reliability. Our results show evidence that novel Flower dry electrodes provide equivalent signal quality compared to gold-standard gel-based electrodes and can be applied for extended periods of time with high wearing comfort both in sitting and supine position. We also demonstrate that increased electrode-skin impedances of dry electrodes are not considerably influencing channel reliability and signal quality in state-of-the-art biosignal amplifiers. Finally, we provide evidence that dry electrodes can be applied in different populations, for varying head geometries and by operators without prior experience in gel-based EEG. Nevertheless, we highlight that training and experience in dry electrode application influence the channel reliability during application.
Our findings highlight the impact and the high potential for dry electrodes enabling mobile and out-of-the-lab EEG, with new fields of application like home-side monitoring, neurofeedback, BCI and social and hyperbrain studies in naturalistic settings.

OR-084

A flexible soft cap for neonatal EEG-NIRS recording produced by additive manufacturing

Mohammed-Reda Mejbar[1], Ralf Hauffe[2], Jens Haueisen[1], Patrique Fiedler[1]
[1]Technical University of Ilmenau, Germany
[2]eemagine Medical Imaging Solutions GmbH, Germany

Neuromonitoring in neonates is essential for assessing brain maturation and detecting early signs of brain damage. The integration of long-term electroencephalography (EEG) and functional near-infrared spectroscopy (fNIRS) into a single monitoring system may support the use of these neuromonitoring modalities in neonatal intensive care units (NICU). Such integration needs to address the challenges posed by the neonates' small head

size, sensitive skin, and hygiene requirements. Our objective is to develop a flexible, customizable cap for neonates that facilitates simultaneous EEG and fNIRS acquisition, ensures good fit, maintains contact pressure below 3N. We developed a compliant cap utilizing additive manufacturing techniques to produce a flexible structure. The structure was optimized for various head sizes and shapes by comparison and implementation of specific design patterns, incorporating expandable lattice structures. We selected a final design derived from auxetic rota chiral patterns which ensures a stable fit and precise control over sensors positioning and contact pressure. We employed parametric design principles to facilitate rapid and efficient integration of varying electrode and sensor layouts. The design parameters enable adjustments in structure thickness, the curvature of the pattern, and scaling in order to adapt the basic design to different head regions. We implemented a semi-automated design process, using an MRI-based 3D model of a neonate's head. This allows using individual MRIs to generate individualized head caps produced with thermoplastic polyurethane powder with Multi Jet Fusion.

A validation protocol has been established to assess the cap's mechanical performance, sensor position accuracy, and adduction. This involved mechanical testing on head phantoms of circumferences ranging from 27 to 39 cm, equipped with a network of flexible capacitive sensors to measure contact pressure accurately for each electrode.

Through the manufacturing and validation of four neonatal cap prototypes, we have successfully fine-tuned the cap's flexibility by adjusting the structural parameters of the pattern (pattern shape, strut thickness, curvature angle, and material). The sensor positioning accuracy was 1.5± 0.5 mm, while the force measurements resulted in a contact pressure of 2.15 ± 0.9 N.

Our developed iterative optimization process has resulted in a novel cap design compatible with additive manufacturing and enabling simultaneous EEG and fNIRS on neonates. The use of a flexible sensor matrix has demonstrated the cap's ability to conform to head curvatures accurately, providing good contact pressure and maintaining comfort. The design process may also be extended to adult cap versions for mechanical validation and signal quality testing in real-world scenarios.

OR-085

Comparison of methods for bad channel detection in dry EEG

Milana Komosar, Patrique Fiedler, Jens Haueisen
Technical University of Ilmenau, Germany

Electroencephalography (EEG) is a non-invasive method for studying brain function. In addition to traditional gel-based recordings, there is a growing interest in dry electrode EEG applications. EEG recording techniques are susceptible to artifacts and noise, leading to the inevitable presence of bad channels in the recordings. Detecting and managing these bad channels is a standard preprocessing step. Due to its inherent mechanical properties, dry EEG is particularly susceptible to artifacts such as movement. Despite this, dry EEG is promising due to its ease of use and potential for self-application in a variety of settings, from laboratories to sports research and home environments. While various algorithms have been developed for bad channel detection, no single optimal choice has emerged for dry EEG applications yet.

We conducted an analysis of bad channel detection in EEG recordings using seven methods: pop_rejchan (kurtosis), pop_rejchan (probability), FASTER, pop_clean_rawdata, PREP-Pipeline, HAPPE, and ISD. These methods were used to identify bad channels in 17 volunteer datasets recorded with a 64-channel dry EEG setup during resting state. The analyzed performance metric was the accuracy of the method. The manual ranking of the channels by an experienced EEG operator has been used as a reference.

The results showed that the ISD method was the most accurate, with an average accuracy of 91.7%. Statistical analysis indicated significantly lower accuracy for all other methods analyzed.

The performance of different bad channel detection algorithms may vary depending on electrode type, channel layout, and acquisition protocol. In our evaluation, seven bad channel detection methods were compared. Considering the results obtained, we suggest using the ISD method for bad channel detection in dry EEG recordings with a 64-channel layout.

OR-086

Technology and study protocol for the multimodal and ecological investigation of joint action in table tennis

Silvia Comani[1], Gabriella Tamburro[1], Antonio De Fano[1], Khadijeh Raeisi Nafchi[1], Mohammad Khazaei[1], Filippo Zappasodi[1], Ricardo Bruña[2], Edson Filho[3], Hannes Oppermann[4], Patrique Fiedler[4]

[1]G. d'Annunzio University of Chieti-Pescara, Italy

[2]Universidad Complutense de Madrid, Spain

[3]Boston University, United States

[4]Technische Universität Ilmenau, Germany

Activities of daily living are permeated by spontaneous or deliberate, conscious or unconscious inter-individual interactions, which can be independent (e.g., accidental encounters) or interdependent (e.g., a couple dancing). The latter type of interpersonal interaction, called joint action, aims at achieving a shared common goal. Elucidating the mechanisms underpinning joint action may have an impact in a variety of social contexts involving mates, colleagues, competitors, genders, up to the understanding and improving of the mechanisms of decision-making. So far, joint action studies have been mainly performed using hyperbrain scanning methods to investigate inter-brain synchrony and the brain-to-brain functional connectivity of two or more interacting individuals by means of multiple synchronized neuroimaging devices.

We designed a novel multimodal experimental setup and dyadic study protocol to investigate the neurophysiological underpinnings of joint action through the synchronous acquisition of brain activity (EEG), muscle activation (EMG), heart activity (ECG), respiration, and body movements from two individuals engaged in ecologic and naturalistic joint actions, and incorporating psychological factors. The EEG systems include a new class of electrodes specifically designed to monitor brain activity during free full body movements, and the multiple devices of different vendors were synchronized through a single-board microcomputer and custom Python scripts. The novel dyadic study protocol permits to best exploit the multimodal data acquisitions. We selected table tennis for the dyadic motor task because it allows naturalistic and face-to-face interpersonal interactions, free in-time and in-space full body movement coordination, cooperative and competitive joint actions, and the implementation of two task difficulty levels to mimic changing external conditions. The recording conditions, including minimum table tennis rally duration, sampling rate of kinematic data, and total duration of the neurophysiological recordings, were defined according to the requirements of a multilevel analytical approach, including neural, cognitive-behavioral, and social levels of investigation.

Our described technical setup provides a novel solution for integrating multiple devices from different vendors in a multimodal setup allowing the simultaneous monitoring and recording of neurophysiological and kinematic signals during the performance of ecological and naturalistic dyadic joint actions. The proposed solutions go beyond the state-of-the-art both on the technological and scientific level. Our novel paradigm and our specifically developed hardware solutions may contribute to advance the understanding of both overt and covert processes occurring during joint actions, and could support the definition of systems able to predict cooperative or competitive behaviors before being overtly expressed.

OR-087

Analysis of hyperbrain data underpinning naturalistic joint action

Gabriella Tamburro[1], Ricardo Bruña[2], Patrique Fiedler[3], Antonio De Fano[1], Khadijeh Raeisi Nafchi[1], Mohammad Khazaei[1], Filippo Zappasodi[1], Silvia Comani[1]

[1]G. d'Annunzio University of Chieti-Pescara, Italy

[2]Universidad Complutense de Madrid, Spain

[3]Technical University of Ilmenau, Germany

In many daily activities, we need to coordinate our actions with those of other people in time and space. Joint action is a form of interpersonal interaction characterized by a shared and public goal that cannot be achieved by acting individually. Joint action is also characterized by individual goals of the interacting people, which can be complementary (i.e., cooperation) or mutually exclusive (i.e., competition). Investigating the neural mechanisms underpinning both cooperative and competitive joint actions may have a relevant impact in many social contexts of human daily life. However, no consensus on the ideal method(s) to characterize global brain dynamics and brain-to-brain coupling has been reached so far, especially for joint action electroencephalographic (EEG) data acquired in a naturalistic context. Moreover, such data may be affected by motion-related technical and biological artefacts.

We propose an effective and generalizable pipeline for the analysis of hyperbrain EEG data acquired in a naturalistic context. EEG signals were recorded simultaneously from two dyads of semi-professional table tennis players involved in cooperative and competitive exchanges. Hyperbrain networks of synchronized activity in the individual brains and across brains were reconstructed using the corrected imaginary part of the Phase Locking Value (ciPLV) between EEG signals. This analysis was performed separately for three frequency bands: theta (4-8 Hz), alpha (8-12 Hz) and beta (12-30 Hz). A k-means clustering approach and graph-theoretical measures were used to disentangle specific features of the hyperbrain, within-brain and between-brains functional patterns and differentiate between cooperation and competition.

Results show that the graph metrics outlining the roles of nodes in the functional networks and the different cluster topographies identified for the within-brain and between-brains patterns can effectively differentiate between cooperation and competition in the three frequency bands. These results suggest that the proposed approach for the analysis of hyperbrain data recorded within a naturalistic paradigm could lead to valuable insights on the brain mechanisms underpinning cooperative and competitive joint action.

IFMBE Young Investigators Competition

Tuesday late afternoon
Track A
Jun 11, 16:00 - 18:00

OR-088

Online Uric Acid Concentration Estimation in Blood from Spent Dialysate Measurements Using an Optical Sensor

Joosep Paats[1], Jürgen Arund[1], Kristjan Pilt[1], Annika Adoberg[2], Liisi Leis[2], Merike Luman[1], Jana Holmar[1], Risto Tanner[1], Ivo Fridolin[1]

[1]Department of Health Technologies, Tallinn University of Technology, Estonia

[2]Centre of Nephrology, North Estonia Medical Centre, Estonia

This study aimed to estimate concentration of uric acid (UA) in blood from online spent dialysate measurements during haemodialysis (HD) with an optical sensor noninvasively. Twenty-two patients on chronic (HD) were monitored during 88 treatment sessions, including HD and haemodiafiltration treatments. Pre- and post-dialysis blood samples and spent dialysate samples, from the drain outlet of HD machine, were collected during each session. HPLC analysis was used as a reference to determine UA concentrations in the samples. An optical sensor was connected to the drain outlet of the HD machine and ultraviolet light absorption of spent dialysate was measured online for each HD session at four different wave-lengths. A linear interactions regression model was used to estimate UA concentrations in spent dialysate with the optical sensor based on the light absorption. Sensor estimated spent dialysate UA concentrations were highly accurate with standard error (SE) < 3.50 mol/L and strongly correlated (R2>=0.983) to the ac-tual UA concentrations of spent dialysate in the training and the test dataset. A linear regression model, using treatment settings and UA concentration deter-mined with optical sensor, was employed to estimate concentration of UA in blood samples. Sensor estimated blood UA concentrations were similarly highly accurate (SE < 32.1 mol/L) and strongly correlated (R2>0.95) to the actual UA concentrations of blood in the calibration and the validation dataset. In conclusion, this study showed that UA levels in blood can be estimated noninvasively with the optical sensor in real time with higher accuracy than shown previously.

OR-089

Comparison of Different Configurations for the Implantable Capacitive Intrabody Communication on a Two-Layer Phantom

Matija Roglić[1], Luka Klaić[1], Ziliang Wei[2], Yueming Gao[2], Željka Lučev Vasić[1]

[1]University of Zagreb, Croatia

[2]Fuzhou University, China

Implantable capacitive intrabody communication is a wireless communica-tion method that utilizes capacitive coupling as a way for the implants to communicate between each other as well as with the devices that are placed on the body. Since there are several possible configurations, such as in-body to on-body (IB2OB) communication and on-body to in-body (OB2IB) com-munication, it is important to investigate how the communication channel behaves for each configuration. Therefore, in this paper, a two-layer 3D model of the upper part of the leg between the knee and ankle has been cre-ated for the measure-

ment purposes. The phantom consists of an outer layer that mimics the fat tissue with a very low conductivity and an inner layer that has a conductivity like the muscle. During the measurements, one pair of electrodes with an insulated ground electrode was inserted into the muscle layer and connected to the transmitter, while the other pair of the electrodes was placed on the phantom and connected to the receiver (IB2OB). After the IB2OB measurements were completed, the transmitter and receiver devices were swapped to measure the OB2IB scenario. The results show that changes in the configuration lead to negligible difference in the measurement results, i.e. the system is reciprocal. Moreover, a high-pass profile was observed for the frequency range from 100 kHz to 84 MHz.

OR-090

Computational hemodynamic Evaluation of Different Surgical Designs of Systemic to Pulmonary Arterial Shunt under Controlled Pulmonary Flow

Jiwen Xiong, Qi Sun, Jinfen Liu, Jinlong Liu
Shanghai Children's Medical Center, School of Medicine, Shanghai Jiao Tong University, China

Systemic to pulmonary arterial shunt including modified central shunt (MCS) and modified Blalock-Taussig shunt (MBTS) are widely applied surgeries to increase pulmonary perfusion. It's crucial to ensure the pulmonary flow was well-controlled within a reasonable range, since both excessive and insufficient pulmonary perfusion leads to poor prognosis. The pulmonary flow could be well-controlled by selecting various shunt designs, e.g. shunt location and size. However, the hemodynamic performance of different designs is less explored under equivalent and reasonable pulmonary flow. Here, the individualized vascular model was reconstructed. To realize appropriated and equivalent pulmonary flow, three virtual surgeries including 4 mm left MBTS, 4 mm MCS, and 5 mm right MBTS were implemented using computer-aided design (CAD). The postoperative hemodynamic parameters were calculated by computational fluid dynamics (CFD). The results showed the postoperative models had equivalent pulmonary flow. The left MBTS had a better performance in balancing the pulmonary flow distribution. The right MBTS had a lower wall shear stress (WSS) and time-averaged WSS region in the shunt. The flow vortex and shear stress fluctuations were hardly avoidable in pulmonary arteries. In conclusion, the appropriate and equivalent pulmonary flow could be well realized by a larger-sized shunt when changing the shunt location of MBTS to the third aortic branch, compared with the MCS. The pulmonary flow distribution is greatly affected by the shunt location and vascular anatomy. The assessment and monitoring of thrombosis risk is requisite during perioperative management and postoperative follow-up no matter what shunt design is applied.

OR-091

Accurate and interpretable deep learning model for sleep staging in children with sleep apnea from pulse oximetry

Fernando Vaquerizo-Villar[1], Daniel Álvarez[2], Gonzalo C. Gutiérrez-Tobal[1], Adrián Martín-Montero[1], David Gozal[3], Eduardo Tamayo[4], Roberto Hornero[2]
[1]University of Valladolid, Spain
[2]Universidad de Valladolid and Centro de Investigación Biomédica en Red en Bioingeniería, Biomateriales y Nanomedicina, Spain
[3]Joan C. Edwards School of Medicine, Marshall University, United States
[4]Biomedical Research Networking Center in Infectious Diseases (CIBERINFEC), Carlos III Institute of Health, Spain

Identification of sleep stages is crucial in the diagnosis of sleep-related disorders but relies on the labor-intensive and manual scoring of overnight polysomnography (PSG) recordings. To simplify the sleep staging process, deep learning (DL) algorithms have been proposed to automatically analyze pulse rate (PR) and blood oxygen saturation (SpO2) signals from pulse oximetry in children with obstructive sleep apnea (OSA). However, existing approaches are perceived as black boxes, limiting their implementation in clinical settings. Accordingly, we develop a DL architecture based on a U-Net to automatically perform 4-class sleep stage classification (wake, light sleep, deep sleep, and rapid-eye movement sleep) using entire-night PR and SpO2 recordings. Furthermore, Semantic Segmentation via Gradient-Weighted Class Activation Mapping (Seg-Grad-CAM), an eXplainable Artificial Intelligence methodology, is proposed to provide an interpretation of the sleep scoring process. PR and SpO2 from 1,633 PSG recordings obtained from the Childhood Adenotonsillectomy Trial database were used for

these purposes. The U-Net model showed a high performance for the 4-stage classification procedure in an independent set, with 78.2?curacy and 0.696 Cohen's kappa. The Seg-Grad-CAM heatmaps revealed that the PR signal has a higher contribution than SpO2 towards sleep staging, while also showing the key roles of mean and variance in PR amplitude, along with changes in the content of PR spectral bands, in the sleep staging process. These findings suggest that an explainable DL model to analyze pulse oximetry signals could be integrated in the clinical environment for automatic sleep staging in abbreviated pediatric OSA tests.

OR-092

Combined measurement of brain activation during a motor task using fNIRS and OPM-MEG

Urban Marhl[1], Stanislaw Wojtkiewicz[2], Piotr Sawosz[2], Vojko Jazbinšek[1], Zvonko Jagličić[3], Adam Liebert[2], Tilmann H. Sander[4]

[1]Institute of Mathematics, Physics and Mechanics, Department of Physics, Slovenia

[2]Nalecz Institute of Biocybernetics and Biomedical Engineering, Poland

[3]University of Ljubljana, Faculty of Civil and Geodetic Engineering, Slovenia

[4]Physikalisch-Technische Budesanstalt Institut Berlin, Optical Metrology, Germany

Neurovascular coupling (NVC) serves as the fundamental mechanism supplying energy to active regions of the brain. NVC is most easily investigated by the simultaneous acquisition of vascular and neuronal responses with two distinct brain imaging methods. In our work, we utilize two non-invasive modalities: functional near-infrared spectroscopy (fNIRS) and magnetoencephalography (MEG). fNIRS measures cortical hemodynamic activity by tracking changes in oxy- and deoxy-hemoglobin concentration. Meanwhile, MEG measures cortical neuronal activity by measuring magnetic fields near the head. Until recently the only suitable sensor for MEG was the superconducting quantum interference de-vice (SQUID), but in the last decade, optically pumped magnetometers (OPM) have advanced to the point where they have similar sensitivities as SQUID mag-netometers. In this work, we present simultaneous measurements of brain activa-tion during a motor task with an integrated system consisting of both modalities: fNIRS and OPM-based MEG. Traditionally, the time scales of the two methods are very different. MEG measures magnetic field changes at frequencies above 1 Hz and fNIRS below this frequency since vascular processes are generally slow. In this work, we show that with OPM-MEG we can measure sustained activity of the brain (below 1 Hz) if the measurements are made in a unique magnetically shielded room with a high shielding factor below 1 Hz and if we use advanced preprocessing methods, such as independent component analysis (ICA).

OR-093

Frequency Domain Cluster Analysis of Human Activity Using Triaxial Accelerometer Data

Krunoslav Jurcic, Goran Šeketa, Ratko Magjarević

University of Zagreb, Croatia, Croatia

This paper presents cluster analysis of triaxial accelerometer data aquired from various human physical activities as well as simulated falls using frequency domain features. Clustering was performed using K Means, Gaussian Mixed Model and Fuzzy C-Means methods. In our analysis we focused on two problems: the first clustering problem being activity recognition and differentiation from simulated human falls, while the other problem focused on distinction between single jerk events (e.g. jumping, falling) and continuous activity signals (e.g. running, walking).

OR-094

Electrochemical detection of desorbed calcium ions from bovine serum albumin binding

Tamara Boscarino, Antonio D'Ambrosio, Andrea Palermo, Vincenzo Piemonte, Leandro Pecchia

Università Campus Biomedico di Roma, Italy

A preliminary detection technique of calcium ion is proposed in this work. It combines the calcium ions desorption from the bovine serum albumin (BSA) binding in buffer solution and the electrochemical detection by cyclo-voltammetry (CV). For this purpose, various concentrations are tested, with particular focus on physiological and pathological values of calcium levels (0 mM, 1 mM, 1.5 mM). Solutions at different concentrations are analysed on the electrode surface by applying a triangular input voltage. The output voltage is represented as a function of the applied voltage by creating a cyclic waveform, the cyclic voltammogram. Focusing on

the closed-loop curve, the measured voltage value progressively increases as the concentration of calcium ions in solution rises, particularly in the range of interest between 0.3V and 0.7V with a Limit of Detection (LOD) of 0.08V. The promising results indicate effective performance. The forthcoming challenge involves utilizing a screen-printed electrode with a carbon/calcium ionophore working electrode.

OR-095

Computational analysis of large bone defect healing using bone tissue scaffolds, degradation, and growth factor delivery: a mechanobiological model of bone tissue formation

Adel Alshammari, Fahad Alabdah, Lipeng Song, Glen Cooper
University of Manchester, United Kingdom

Large bone defects are a significant medical challenge. 3D printed synthetic biocompatible and biodegradable bone tissue scaffolds offer a possible clinical solution. Degradability of these bone scaffolds within the body precludes the need for additional interventions allowing native bone to replace the implant during healing. Degradation rates can be altered by chemical composition but the optimal design of these rates to maximize bone growth is unknown. Many researchers have conducted experiments on degradation, but this is time consuming and difficult to measure particularly in vivo. Mechanobiological models to evaluate degradation and bone healing for bone tissue scaffolds would be an attractive option to design bone tissue scaffold degradation but these are not widely available. This study aims to model both bone healing and scaffold degradation for a bone tissue scaffold integrating agent-based modelling and finite element analysis (FEA). It introduces an innovative computational method to examine the effects of scaffold degradation rates (slow, medium, and fast) and the incorporation of embedded bone morphogenetic proteins (BMPs) on bone regeneration. The results indicated that scaffold degradation at a medium rate of 6% volume reduction per day resulted in the greatest volume of regenerated bone by 18.2mm3, in contrast to slow and fast degradation by 16.4mm3 and 18.1mm3, respectively. The case using medium scaffold degradation with embedded BMPs enhanced bone regeneration, resulting in a further increase of 2 mm3 of bone volume. Further work is planned to calibrate the model and to apply these techniques to optimize bone tissue scaffold designs.

S24 - Wireless Wearable Networks for Physical Function Rehabilitation Monitoring

Tuesday late afternoon
Track C
Jun 11, 16:00 - 18:00

OR-096

Revealing Statistical Patterns in Shoulder Rehabilitation Exercises Characteristics

Martina Sassi, Margherita Anna Grazia Matarrese, Umile Giuseppe Longo, Leandro Pecchia
Campus Bio Medico University of Rome, Italy, Italy

Tele-rehabilitation has the potential to transform the way patients are monitored from home, overcoming geographical barriers, enhancing accessibility, and promoting patient autonomy. The development of a tele-rehabilitation system capable of automating the recognition of performed exercises may significantly impact rehabilitation outcomes. Implementation of machine learning algorithms combined with magneto-inertial measurement units (M-IMUs) has enabled remote home-based rehabilitation therapy through wearable systems. Thus, in this study sixteen healthy participants and sixteen patients with rotator cuff injuries were enrolled to perform six shoulder rehabilitation exercises while wearing a wearable system based on three M-IMUs. This study aimed to conduct a thorough analysis of the features extracted from time-series data collected by these three sensors during these exercises. The statistical analysis indicated statistically significant differences in task features, but not between participant groups. Three features, identified as the most representative and distinctive among all tasks, were subsequently, used to train the Support Vector Classifier in classifying the six exercises. The obtained classification results are promising for the application of this wearable device in remote monitoring of patients with shoulder musculoskeletal disorders during home-based rehabilitation exercises. Further studies will involve the implementation of the Principal Component Analysis (PCA), along with the training of additional machine learning models.

OR-097

Body Movement Analysis during Sleep Based on Ultra-Wideband Communication Channel Impulse Response Measurement

Ivana Culjak[1], Željka Lučev Vasić[2], Domagoj Vidović[3], Mario Cifrek[2]

[1]KITE-Toronto Rehabilitation Institute, University Health Network, Canada

[2]University of Zagreb, Croatia

[3]University Psychiatric Hospital Vrapče, Croatia

The study introduces an innovative non-invasive method using Ultra-Wideband (UWB) technology for monitoring body movements during sleep. Conducted at the Center for sleep and wake disorders, the research involved positioning UWB devices with two transmitters and receivers on either side of the bed, approximately 0.5 meters from the patient. Ground-truth measurements were done using a polysomnography (PSG) system. The analysis was conducted in 30-second epochs, involving 17 participants over 103.41 hours. This method leverages UWB's Channel Impulse Response (CIR) to monitor body positions and movements, serving as an alternative to traditional radar-based approaches. The research highlights UWB's potential in understanding sleep patterns and quality, showing the interplay between body movements, sleep phases, and respiratory events. This study can contribute to sleep medicine by offering a new method for sleep disorder management, marking progress in non-invasive sleep monitoring technologies. The comparison with conventional polysomnography provides valuable insights into the efficacy of UWB technology in improving sleep monitoring.

OR-098

Comparison of Time and Frequency Domain Features For Cluster Analysis of Human Activity Using Triaxial Accelerometer Data

Krunoslav Jurcic

University of Zagreb, Croatia

This abstract presents a summary of two studies focusing on comparison of the impact of both time and frequency domain features in analysis of tri-axial accelerometer data acquired from various human physical activities as well as simulated falls. The goal was to get insights on the performance of several clustering algorithms when dealing with different human activities, and whether they can distinguish activities of daily living from falls, treating it as a binary clustering problem. Another approach included different signal labelling depending on its continuity, exploring the possibility of recognizing and separating a single occurrence (e.g. falling or jumping) event from a continuous activity such as running or walking, questioning whether we can gain new insights in the field of human activity recognition and fall detection. Clustering was performed using three different clustering methods: K Means, Gaussian Mixed Model and Fuzzy C-Means clustering. For the time domain feature models' performance, Gaussian Mixture Model (GMM) proved to perform best regarding both the first (89?curacy, 92? score for ADL and 86? score for falls) and the second clustering problem (68?curacy, 64? score for continuous activities and 70? score for single events). As for the frequency domain models, there is no significant differences in performances among the clustering methods. K Means and Fuzzy C Means models performed with slightly higher results for the first clustering problem (77?curacy and 85 ? score compared to 75 ?curacy and 80? score of GMM), while the models perform similar regarding the second clustering problem.

OR-099

Dynamic Equivalent Circuit Models for Intracardiac Communication in Leadless Pacemakers

Dongming Li[1], Jiamei Wang[2], Pedro Antonio Mou[1], Yadong Yin[2], Hung Chun Li[3], Yueming Gao[2], Peng Un Mak[1], Sio Hang Pun[1], Mang I. Vai[1]

[1]University of Macau, China

[2]Fuzhou University, China

[3]Lingyange Semiconductor Inc., China

The leadless multichamber pacemaker offers significant advantages in treating arrhythmias and enhancing cardiac function. Intracardiac communication is crucial for enabling synchronous pacing of multi-chamber non-leadless pacemakers. However, the dynamic changes in the intracardiac channel present a significant challenge. Hence, mastering the dynamic characteristics of intracardiac channels and accurately modeling them is crucial. In this paper, we propose an intracardiac channel equivalent circuit model, which is based on the electrical properties of cardiac tissue and the volume changes of cardiac compartments, and is experimentally validated. The results demonstrate that the agreement coefficient between the circuit model and the in vitro pig heart model reached 80.7

OR-100

Cardiac Phantoms for Signal Transmission Characteristics Analysis of Leadless Pacemakers

Han Wang[1], Jiamei Wang[1], ***Yang Shuang***[1], Ziliang Wei[1], Željka Lučev Vasić[2], Jiejie Yang[1], Zhimeng Xu[1], Mario Cifrek[2], Yueming Gao[1]

[1]Fuzhou University, China

[2]University of Zagreb, Croatia

The emergence of leadless pacemakers marks a revolutionary breakthrough in cardiac rhythm management. However, current leadless cardiac pacemakers (LCPs) can only pace at a single location, which fails to meet the demand for multi-ventricular sequential pacing in most patients. To address this limitation and achieve multi-chamber pacing with LCPs, it is essential to analyze the signal transmission characteristics of intracardiac conduction communication.Many existing studies analyze the signal transmission

characteristics of intracardiac channels based on static experimental measurements. However, our previous research revealed that the signaling characteristics of intracardiac channels vary with the cardiac beat cycle. Consequently, it is inaccurate to consider the channel gain measured in any arbitrary state as representative of the channel characteristics during the establishment of intracardiac signaling communication. Thus, the measurement results cannot be reliably used as a reference for LCP design.In this study, we developed a semisolid spherical mimic using a mixture composed of 91.94?ionized water, 2.63% agar, 0.18% potassium chloride, and 5.25% hydroxyethylcellulose (HEC). This mimic was designed to simulate the channel characteristics during the establishment of intracardiac signal conduction communication. The experimental measurements of the mimic demonstrated a difference of no more than 2 dB compared to the dynamic measurements of the isolated porcine heart in the frequency range of 1 MHz to 20 MHz. This mimic offers a highly accurate, reproducible, and stable method to analyze the signal transmission characteristics of intracardiac channels in conductive cardiac communication(CIC) studies. Moreover, it provides an effective reference for CIC transceiver design studies.

OR-101

Impact of the Tightness of a Sensorized Top in the Quality of the ECG it Records

Marta Guzmán-Alarcón, Natalia Guzmán Rodríguez, Pablo Pérez-Tirador, Constantino A. García, ***Abraham Otero***

University CEU San Pablo, Spain

The telemonitoring of physiological parameters can provide useful information for chronic diseases management and for the identification of life-threatening situations. However, to achieve continuous adherence to the technological solution, it must be comfortable and easy to use. To this end, the sensorization of commercial garments through the integration of conductive textiles is a promising solution. In a previous work three sensorized garments (pants, shirt and top) to record ECG were compared [1]. The top provided a higher quality, but it also was the tightest. However, since three different garments were used, it is difficult to draw conclusions about the impact of the tightness on the ECG quality.

This work studies the impact of the tightness of a sensorized top on the quality of the ECG. Three sensorized tops of different sizes (M, S, XS) were built from the same commercial garment. The choice of sizes was based on the test subject (20-year-old woman, 1.59 m, 47 kg). Size S would be her natural size, with M being slightly loose and XS being too tight and somewhat uncomfortable.

A silver-plated conductive fabric (Adafruit Industries LLC; New York, USA) and a steel conductive thread (SparkFun Electronics Inc; Colorado, USA) were used for the sensorization. Using the conductive thread, a connection was created between the electrodes and the data acquisition unit (Plux Wireless Biosignals S.A.; Lisbon, Portugal). The data was recorded with a mobile terminal.

Four 8-hours recordings were made for each garment while performing daily living activities. The mSQI ECG quality index [2] was used to compare the recordings. The average value for the 4 days (approximately 36 hours) of msQIs in the M top was 0.55±0.14, in the S 0.74±0.08 and in the XS 0.71±0.08. These values suggest that it is possible to achieve a balance between the quality of the signal and the comfort of the garment: while the excessively loose top (size M) does produce a signal of a markedly lower quality, the quality of sizes S (the subject's natural size) and XS (too tight) is equivalent, presenting no increase in quality

associated with the tighter garment.

[1]A. Grech, C.A. García, A. Otero Evaluation of three sensorized garments with conductive textiles for ECG recording. CASEIB 2023, Spain.
[2]A. Grech, C.A. García, P. Perez-Tirador, A. Otero. A metric index to assess the quality of wearable ECG recordings. IEEE BSN, 2023 Boston, EEUU.

OR-102

Impedance Cardiography signals in applications for cardiovascular information content analysis

Gerard Cybulski, Tadeusz Pałko, Kazimierz Pęczalski
Faculty of Mechatronics, Warsaw University of Technology, Poland

The analysis of cardiovascular system response to various physiological stimuli including active orthostatic maneuver, head-up tilt test, handgrip or dynamic exercise may provide some supplementary diagnostic data on autonomic control activity and might help to predict the occurrence of some critical events, e.g. orthostatic syncope. Heart rhythm/rate variability (HRV) has been intensively studied in supine and other body positions in humans. However, only limited study results were published describing rhythms, fluctuations and generally dynamics of hemodynamic parameters, especially monitored during transient phase of physiological tests. Moreover, they were in much smaller groups of subjects. Impedance cardiography, which allows non-invasive, continuous monitoring of mechanical activity of the heart (including ambulatory conditions) seems to be the method suitable to perform this type of analysis.
The analysis of cardiovascular hemodynamics appears to be a potential source of diagnostic information on mutual coupling between the cardiovascular system and autonomic nervous system dysfunction or modification induced by several environmental and/or pathological factors So far researchers used either descriptive statistics method or power spectrum analysis for analysis of absolute values, their changes of stroke volume (SV), stroke volume output velocity (SVOV), ejection time (ET), pre-ejection period (PEP) and additional systolic time intervals or other parameters derived from ICG signals. They also tried to apply measures of complexity (sample entropy, approximate entropy, etc.) or time series causality methods (e.g. Granger causality) to predict the occurrence of critical health incidences.
In our laboratory we used ICG derived stroke volume and systolic time intervals (STI) changes (including their variability) to analyze the hemodynamic response to active and passive orthostatic maneuver, handgrip, dynamic exercise, Valsalva maneuver. We applied our described earlier ambulatory impedance cardiography wearable system (Reomonitor). This device was constructed for non-invasive acquisition of central hemodynamic data during everyday activity. Stroke volume was evaluated using the Kubicek formula. The validation of impedance cardiography has been performed many times. Reomonitor was verified using echocardiography in both the supine and tilted position. Some studies has shown the usefulness of ICG in monitoring the effects of neurodegenerative processes, analysis of sleep apnea disorders, monitoring the effectiveness of physical training and predicting orthostatic intolerance.
The aim of this study is to deliver the review of some possibilities and prospects of extracting diagnostic information from analysis of impedance cardiography signals (ICG).

OR-103

An Everyday Hat for Detection of Eye Blinks and Forehead Clenching

S. M. Musfequr Rahman, Henna Mattila, Asif Shaikh, Pasi Raumonen, Johanna Virkki
Tampere University, Finland

This paper presents an early prototype of an everyday hat capable of detect-ing eye blinks and forehead clenching and turning them into inputs for digital actions. In fabrication, commercially available standard dry and semi-dry Ag/AgCl electrodes are compared to dry and semi-dry electrodes fabricated from copper and silver-based textiles and silver-based thread. According to measurements from six participants, the created hat prototype with integrated electrodes is fully comparable to a commercially available electrode holder band, while the copper-based textile electrodes have detection accuracy for eye blinking and forehead clenching comparable to the standard Ag/AgCl electrodes. Among all materials, the semi-dry electrodes have better detection accuracy than the dry electrodes. Finally, a proof-of-concept application of the hat, turning light on/off by eye blinks

and forehead clenching, reveals more than 80 % success rate, when tested by four participants.

S09 - Health Technology Assessment of Medical Devices - Advances and Challenges

Wednesday morning Track A
Jun 12, 10:30 - 12:00

OR-104

Exploration and practice of quality control index system of medical device management

Yueqi Yang[1], Yingxin Xu[1], Xin Li[1], Xiangnan Geng[1], Xiang Xu[1], Hong Gao[1], Yuzhi Yang[2], Wei Jin[3], Hui Zhong[4], Ying Qian[1]

[1]Jiangsu Province Hospital, China

[2]Nanjing Drum Tower Hospital, China

[3]Wuxi People's Hospital, China

[4]Subei People's Hospital of Jiangsu province, China

Objective Quality control indicators are an important component of the medical quality management and control system and are crucial tools for quality management. It is essential to explore the establishment of a quality control indicator system for the management of medical equipment and instruments to ensure the safety and effectiveness of clinical applications of medical devices. Method The selection and establishment of quality control indicators should follow three principles: scientificity, standardization, and operability. This can be achieved through extensive research, expert consultation, and centralized discussions. The selected indicators should cover multiple dimensions such as structure, process, and outcomes. The consultation for medical equipment and instrument management quality control indicators should include experts in the field, as well as experts from related professions within medical institutions (such as medical, nursing, hospital management, etc.), and opinions from competent authorities (such as health commissions at various levels). For some special technical indicators, opinions and suggestions from representative equipment and instrument manufacturers should also be sought. Results The Jiangsu Province Medical Equipment and Instrument Management Quality Control Indicators (2022 Edition) have been revised and improved based on previous quality control data collection and analysis results, leveraging the professional resources of experts at the provincial medical equipment and instrument management quality control center. The 2022 edition of the quality control indicators has been optimized from the 54 items in the 2018 edition (13 quarterly reporting indicators and 41 annual indicators) to 15 items (9 quality control indicators reported each quarter and 6 quality control indicators reported each year). Conclusion Since the release of the Jiangsu Province Medical Equipment and Instrument Management Quality Control Indicators (2022 Edition) in November 2022, after specialized training through online and offline quality control meetings, 4 sets of quarterly data reports and 2 sets of annual data reports have been completed, with overall positive feedback. Quality control entities can compare their reported quality control data with regularly published quality control reports to position their own quality control work and carry out continuous improvements.

OR-105

Cost-effectiveness of Continuous Glucose Monitoring For Paediatric Patients With Type 1 Diabetes Compared With Self-Monitoring Of Blood Glucose

Martina Andellini[1], Riccardo Schiaffini[1], Matteo Ritrovato[1], Leandro Pecchia[2]

[1]Bambino Gesù Children's Hospital, Italy

[2]Università Campus Biomedico di Roma, Italy

BACKGROUND Type 1 diabetes (T1D) is one of the most common chronic disease in pediatric age. Frequent blood glucose measures are required to reduce the risk of severe adverse events and the onset of long-term complications. Continuous glucose monitoring (CGM) has been showed to improve glycemic control in adults compared to finger prick measures (SMBG), however scarce evidence is available on pediatric patients. This study aims at determining the cost-effectiveness of CGM compared to SMBG in a pediatric population. METHODS A four states Markov Model (T1D, ketoacidosis, cerebral injury, death) was developed by using data inputs retrospectively collected at Bambino Gesù Children's Hospital. Data from patients who have been using CGM for at least three years were included in the analysis and compared with patients who use SMBG. Hba1c level, glycemic variability and quality-of-life were estimated by administering ad hoc questionnaires to evaluate clinical

benefits. Transition probabilities were estimated by retrospectively collecting data from hospital registries and the costs from available literature and national sources. The analyses were performed by simulating 100 patients over 16 years horizon. The main outcome was cost per quality-adjusted life-year (QALY) gained.
RESULTS Results showed that all health outcomes improved during follow-up when patients used CGM instead of SMBG. Namely, the number of hospitalizations, DKA and cerebral edema reduced for patients who use CGM as a consequence of a better T1D management. Managing T1D with CGM was associated with lower disease-related costs and higher utilities as compared to SMBG. The cost per quality-adjusted life year gained by using CGM is approximately 12,373.54€/QALY, that represents the expected cost per QALY by relying on the CGM instead of the SMBG.
CONCLUSIONS Each patient who manages T1D with CGM cost 43,726.91€ more than patients who use SMBG over 16 years, with an increment of 3.53 QALYs. Neverthless the higher initial cost of CGM is counterbalanced by the health benefits which lead to the reduction of the number of severe acute events, with a consequent reduction of the related complications costs resulting in cost-effectiveness.

OR-106

Optimizing Liver Stiffness Assessment in HCV Patients: A Machine Learning Approach to Identify Confounding Factors in Fibrosis Estimation

Simone Kresevic[1], Mauro Giuffrè[2], Milos Ajcevic[1], Lory Croce[1], Agostino Accardo[1]
[1]University of Trieste, Italy
[2]Yale School of Medicine, Yale University, Italy

Hepatitis C Virus (HCV) infection is a significant global health con- cern with approximately 1.5 million new infections yearly. The choice of the most appropriate HCV treatment depends on several factors, including liver fi- brosis status. Current guidelines recommend liver fibrosis evaluation using non-invasive techniques such as Liver Stiffness Measurement (LSM) using liver elas- tography. Although LSM revolutionized patient care in the last decade, allowing biopsy-free treatments, several factors can lead to overestimation or underesti- mation of liver stiffness values, affecting management strategies. This study pre- sents a machine-learning approach using an eXtreme Gradient Boosting model to predict possible LSM inaccuracies in a cohort of 509 HCV-positive treated patients. The dataset, characterized by 55 variables, underwent feature reduction and balancing to mitigate class imbalance to train the predictive algorithm. The developed model can identify inaccuracy in LSM and achieves an accuracy of 88.0% on the training set and 92.0% on the test set. Furthermore, it exhibited a consistent mean Area Under the Curve One-vs-One (AUC-ovo) of 0.97 across both datasets. The model's performance in predicting abnormal LSM may enable healthcare providers to tailor treatment plans more precisely, optimize patient follow-up, and reduce unnecessary invasive procedures. These findings highlight the potential of machine learning in improving patient care in the context of chronic HCV management.

OR-107

Advances in Health Technology Assessment of Wearable Devices: A Clinical Engineering Perspective

Fabiola Martinez-Licona
Universidad Autonoma Metropolitana, Mexico

Wearable devices have revolutionized healthcare delivery by continuously monitoring vital signs and other health parameters in real time. As these devices become increasingly sophisticated, rigorous health technology assessment (HTA) to evaluate their effectiveness, safety, and cost-effectiveness becomes paramount. Here, we explore recent advances in HTA methodologies specific to wearable devices from a clinical engineering perspective.
First, an overview of wearable devices and their growing importance in healthcare is provided, highlighting their potential to improve patient outcomes, enhance remote patient monitoring, and facilitate early disease detection. It then delves into the challenges of assessing wearable devices, including data accuracy, privacy concerns, and regulatory requirements.
Next, a brief exposition of the current state of HTA methodologies for wearable devices emphasizes the importance of multidisciplinary collaboration between clinical engineers, healthcare providers, and researchers. The role of clinical engineering in designing robust evaluation protocols, conducting clinical trials, and analyzing real-world data to assess the clinical utility and value of wearable devices is

discussed.
Furthermore, the abstract explores emerging trends in HTA, such as the integration of artificial intelligence and machine learning algorithms to analyze wearable device data, predictive modeling techniques to forecast health outcomes, and patient-centered approaches to HTA that incorporate patient preferences and experiences.
Finally, future directions and challenges in HTA of wearable devices, including the need for standardized assessment frameworks, validation studies to establish the reliability and accuracy of wearable device data, and long-term outcomes research to evaluate their impact on population health and healthcare delivery, are discussed.

OR-108

Alarms Early Detection in Dialytic Therapies via Machine Learning Models

Alessia Nicosia[1], Nunzio Cancilla[1], Marco Siino[1], Michele Passerini[2], Francesca Sau[2], Ilenia Tinnirello[1], Andrea Cipollina[1]
[1]Università degli Studi di Palermo, Italy
[2]Mozarc-Medical company, Italy

Hemodialysis (HD) is a clinical treatment for patients affected by Chronic Kidney Dis-ease (CKD). The goal of a treatment is to purify the patient's blood using dialysis machines, devices that act as artificial kidneys. However, a common problem is the alteration of the patient's health status due to side effects or to machine malfunctions that may occur during treatment. A dialysis machine is a complex apparatus consisting of a control system of several quantities (e.g., pressure, flow rate, temperature, conductivity, etc.) capable of alerting medical operators when an alarm occurs. In the present work, a Machine Learning (ML) predictive model able to act in advance with respect to the dialysis alarm system was developed. Several machine learning mod-els were tested and a comparison study was carried out. Datasets for training and testing the mod-els came from treatments performed by dialysis machines manufactured by Mozarc-Medical®. Among the models tested, the Random Forest (RF) classifier was identified as the more promising one and was then used to perform a parametric sensitivity study. By using a time window of 10 seconds, the RF model provided a Recall of 79% and an F1-Score of up to 85% on test data, demonstrating the good generalization ability that is always required by predictive models such as the one analysed in this paper.

OR-109

Exploring the Potential of Health Data: EHDS, Secondary Utilization, and Stakeholder Perspectives in Czech Healthcare

Petra Hospodková, *Martin Budil*
Czech Technical University in Prague, Czech Republic

The European Health Data Space (EHDS) introduction has raised a discussion on the use of health data (HD) for secondary purposes that could essentially improve health systems efficiency. This research examines how key stakeholders in the Czech Republic feel about this process. In qualitative analysis (interviews), two major themes were identified with regard to the use of health data: Risks and Barriers, as well as Health Data Access theme. We investigated views and perspectives of 8 key stakeholders from healthcare sector (insurance companies representatives, Ministry of Health, IT technologies, data applicants etc.). These opinions were analyzed using software MAXQDA 24 and compared to better understand the challenges and benefits associated with using health data for secondary purposes. According to our study, the benefits surpass the risks and barriers shown by secondary utilization of health data. The stakeholders highly appreciated making this data accessible to enhance quality care and efficiencies in the healthcare system. Therefore, this study's outcomes are an aid in understanding and promotion of use of health data within EHDS confines. Furthermore, they will be valuable not just to researchers but also policymakers, businesses, and the public interested in harnessing health data to enhance the healthcare system.

S22 - Tools, technologies and computing for point-of-care person-centered health and care delivery

Wednesday morning Track B
Jun 12, 10:30 - 12:00

OR-110

Pointwise reliability of machine learning models: application to cardiovascular risk assessment

Jorge Henriques[1], *Teresa Rocha*[2], Simão Paredes[2], Paulo Gil[3], João Loureiro[1], Lorena Petrella[1]

[1]University of Coimbra, Portugal

[2]Polytechnic Institute of Coimbra, Coimbra Institute of Engineering (IPC/ISEC), Portugal

[3]CTS, Dep. of Electrical and Computer Engr. NOVA School of Sci. and Technology, Portugal

Machine learning has made significant advances in many areas, particularly in the healthcare domain. However, despite the advances, the implementation of these models in clinical scenarios is still limited due to several challenges, including the lack of trust. Standard performance measures, such as sensitivity, specificity and confidence intervals can be used to evaluate the reliability of a model, but these are overall performance metrics and do not provide insight into the performance of individual instances. Moreover, these estimates are typically calculated during the training phase and are not easily generalized to new, unseen instances, occur-ring in the deployment phase.

As result, besides the prediction outcome, the existence of a measure of reliability in the prediction of individual estimations would add a layer of security, increas-ing trust in human-AI interaction, as well as it could also be helpful to support the improvement of the model. This study proposes a reliability measure, combining density and local fit principles, to estimate the confidence of individual predic-tions in the deployment phase. When applied to a machine learning model in the cardiovascular risk assessment context, the method demonstrates the ability to distinguish between reliable and unreliable predictions, as well as aiding in the stratification of the population.

OR-111

Towards Wearable Continuous Point-of-Care Monitoring for Deep Vein Thrombosis of the Lower Limb

Eleni Kaldoudi[1], Vaidotas Marozas[2], Pavlos Moustakidis[3], Dmitry Novikov[4], Jurkonis Rytis[2], Andrius Sakalauskas[4], Nicolas Pousset[5], Mathieu Legros[5], Marco Kircher[6], Babajide Ayinde[3], Lara Alessia Moltani[7], Susann Balling[8], Antti Vehkaoja[9], Niku Oksala[9], Andrius Macas[10], Neringa Balciuniene[10], Maria Bigaki[11], Michail Potoupnis[11], Stella-Lida Papadopoulou[11], Elvira Grandone[12], Maxime Gautier[13], Sabrina Bouda[13], Cord Schloetelburg[14], Thorsten Prinz[14], Pietro Dionisio[15], Spyridon Anagnostopoulos[16], Ioanna Drougka[16], Frans Folkvord[17], George Drosatos[1], Stylianos Didaskalou[1]

[1]Athena Research Center, Greece

[2]Kaunas University of Technology, Lithuania

[3]EchoNous Inc, United States

[4]TELEMED UAB, Lithuania

[5]VERMON SA, France

[6]Fraunhofer Institute for Photonic Microsystems, Germany

[7]ComfTech SRL, Italy

[8]medis Medizinische Messtechnik GmbH, Germany

[9]Tampere University, Finland

[10]Lietuvos Sveikatos Mosklu Universitetas, Lithuania

[11]Papageorgiou General Hospital, Greece

[12]Fondazione Casa Sillievo Della Sofferenza, Italy

[13]Groupement Hospitalier Eaubonne Simone Veil, France

[14]VDE Verband der Elektrotechnik Elektronik Informationstechnik eV, Germany

[15]Medea SRL, Italy

[16]Phaze Clinical Research and Pharmaceutical Consulting SA, Greece

[17]PredictBY Research and Consulting SL, Spain

Deep vein thrombosis (DVT) is the formation of a blood clot within the deep veins, most commonly those of the lower limbs, causing obstruction of blood flow. In 50% of people with DVT, the clot eventually breaks off and travels to the lung to cause pulmonary embolism. Clinical assessment of DVT is notoriously unreliable because up to 2/3 of DVT episodes are clinically silent and patients are symptom free even when pulmonary embolism has developed. Early diagnosis of DVT is crucial, and despite the progress made in ultrasound imaging and plethysmography techniques, there is a need for new methods to enable continuous monitoring of DVT at the point of care. This paper presents the conceptual design and methodology towards a novel wearable diagnostic device for point-

of-care, operator-free, continuous monitoring in patients with high DVT risk. The device will combine novel wearable hardware for ultrasound imaging and impedance plethysmography with autonomous, AI driven DVT detection, to allow continuous monitoring for blood clot formation in the lower limb. Activity and other physiological measurements will be used to provide a continuous assessment of DVT risk and guide the automated scanning via an intelligent decision support unit that will provide accurate monitoring and alerts. The work is supported by the Horizon project ThrombUS+ co-funded by the European Union. (Grant Agreement No. 101137227).

OR-112

Attention Theory Based 12 Lead Visualization of Ventricular Function During Ventricular Pacing Lead Implants

Neal Duong[1], Jessica Lee[2], Paul A. Iaizzo[1]
[1]University of Minnesota, United States
[2]Arizona State University, United States

Optimal cardiac pacing lead implantation is a critical yet complex procedure necessitating the electrophysiologist's attention to ensure accurate placement, appropriate hemodynamic responses, and an elicited electrical morphology confirmation for improvement of patient outcomes. This study introduces an innovative, low-computational methodology based on attention theory to transform the conventional 12-lead EKG format into a more readily visual response. Leveraging both object-based theory and the proximity compatibility principles, the developed method converts the visually separated V1-V6 precordial leads' wave morphologies and amplitude information into a colormap format; to condense the complex data into a more observable signature of ventricular function.
Implemented in Python algorithms, our method offers a dynamic ECG data visualization, utilizing a notch filter for signal cleaning and converting absolute lead values into a responsive color map. The resulting heatmap representation allows the implanting electrophysiologist to identify subtle changes in ongoing pacing morphologies more efficiently in a clinical environment. The colormap, with high amplitudes depicted in yellow and lower amplitudes in red along a gradient, offers a visually intuitive means for the real-time assessment ventricular functions.
Focusing on key pacing sites, including the right ventricular (RV) lateral, apical, and septal zones, alongside intrinsic waveforms, our graphical user interface (GUI) facilitates the precise definitions of time intervals, providing a valuable tool for investigating temporal variations in ECG amplitudes. Observations based on the heatmap morphologies enable distinct identifications of ventricular depolarizations and timings. Shown here, traditional RV apex pacing exhibits a dual RV-LV depolarization, while RV lateral wall pacing manifests wider QRS morphology with a right-dominant depolarization. Conversely, RV septal pacing resembles intrinsic signals but displays a fragmented RV depolarization. These signals have the potential to democratize 12 lead ECG interpretations and improve procedure efficiencies towards more physiologic pacing.
Beyond potential improvements in procedure times, our developed QRS representation could also provide insights as to relative anatomic locations, hence reducing reliance on fluoroscopy during lead placement procedures. Thus, such could not only contribute to enhanced patient outcomes and reduced procedure times, but also address concerns regarding ionizing radiation exposures to both patients and clinicians. Our study underscores the evolving landscape of cardiac interventions, emphasizing a balance between technological advancements and patient-centric care. Overall, this research could significantly benefit implanter's precision, as well as the safety of cardiac procedures, ultimately enhancing patient care in cardiovascular medicine.

OR-113

Integration of in-vitro technologies, in-silico biophysical and data driven models towards better stratification and care for hypertrophic cardiomyopathy patients

Jari Hyttinen
Tampere University, Finland

Hypertrophic cardiomyopathy (HCM) is the most common inherited cardiac disorder. It is a multifactorial and multiorgan disease with multiple manifestations, giving rise to a range of symptoms and complications including chest pain, arrhythmias, and sudden cardiac death. It has various comorbidities impacting e.g., the circulatory system and multiple physiological organs, which may lead to stroke or many neurological and psychological

complications. It affects all age groups from children to the elderly, it is a leading cause of death among young athletes. Implantable cardiac defibrillators are used for HCM patients to prevent sudden cardiac death. Multiple causal mutations and variations in cellular processes lead to highly diverse phenotypes and disease progression that are not fully understood. HCM is still diagnosed as one single disease, leading to suboptimal care. Better tools for deep phenotyping of patients are needed to produce better assessments of risk and care options.
The SMASH-HCM EU HORIZON-HLTH-2023-TOOL-05-03 project will develop and validate a digital twin platform to support patient self-management and aid clinicians in delivering optimized cost-effective stratification and patient management strategies tailored to individual patient pathophysiology, genotype and phenotype. SMASH-HCM unites 8 research partners, 3 hospitals, 3 SMEs, and a global health-technology corporation in collaboration with patients to advance the state of the art in human digital-twins.
SMAASH_HCM integrates in-vitro cell and tissue models, in-silico modelling from molecular manifestation of the disease to patient cellular, tissue, whole heart and finally cardiovascular systemic level models. The in-vitro and in-silico model insight on the disease and drug mechanisms and their data and structured clinical and unstructured data analysis will lead to data-based models with emphasis on explainable artificial intelligence. All these will be integrated into a three level decision support solution for both healthcare with deep phenotyping and risk stratification tools to support clinical workflows and decision making enabling the development of effective personalized treatment and for the patients for their self-management. SMASH-HCM will provide tools for detailed personalized assessment of the need, risks, and benefits involved, making the identification of the need for ICDs substantially easier. In addition, SMASH-HCM presents a well-defined pathophysiology and servers as a paradigm to understand the broader spectrum of hypertrophy, translating to other myopathies and cardiac diseases and beyond. In reaching its goals, SMASH-HCM has potential to serve as a basis for future digital-twin platforms for other cardiac diseases integrating models and data from various scales and sources.

OR-114

Development of an Explainable Deep Learning-Based Decision Support System for Blood Glucose Levels Forecasting in Type 1 Diabetes Using Edge Computing

Isabel Longo[1], ***Federico D'Antoni***[2], Lorenzo Petrosino[1], Vincenzo Piemonte[1], Mario Merone[1], Leandro Pecchia[1]

[1]Università Campus Bio-Medico di Roma, Italy

[2]Fondazione Policlinico Universitario Campus Bio-Medico, Italy

Maintaining blood glucose levels within the euglycemic range to avoid hypo/hyperglycemic events is a very important and complex challenge for people with Type 1 Diabetes. Current solutions employ complex deep learning models requiring substantial computational resources, often necessitating cloud-based processing, raising privacy concerns and significant CO2 emissions. Furthermore, the 'black-box' nature of these neural networks obscures the reasoning behind their predictions, impeding user trust and understanding.
This paper introduces a decision support system leveraging a Long Short-Term Memory (LSTM) neural network for glycemic forecasting that utilizes solely Continuous Glucose Monitoring (CGM) data, using edge-computing for overcoming some of the above limitations. We present a streamlined model with an architecture optimized for edge devices, ensuring data privacy and reducing CO2 emissions by eliminating the need for transmitting and storing more than needed sensitive data. The system encompasses a full communication pipeline from CGM data acquisition and transmission to on-device prediction, culminating in the display of results for patient consultation.
Our findings show that the model's performance, with an average Root Mean Square Error of 14.22 mg/dL and Clarke Error Grid Analysis with 91.95% of predictions in zone A and 7.05% in zone B for a prediction horizon of 30 minutes, is on par with current high-standard models. Crucially, we integrate a renowned explainability algorithm to elucidate the predictive process, offering valuable insights into the model's decision-making framework. This transparency aims to bolster user confidence and facilitate a deeper understanding of the predictive outcomes, marking a significant advancement in personalized diabetes management.

OR-115

Enhancing Balance Rehabilitation through use of Augmented Reality

Aleksandra Vulović[1], Đorđe Ilić[2], Nenad Filipovic[1]

[1]University of Kragujevac, Serbia

[2]Bioengineering Research and Development Center (BioIRC), Serbia

Falls bear profound physical, psychological, and societal repercussions alongside imposing substantial healthcare costs and diminishing quality of life. Among the primary risk factors contributing to falls is impaired balance, stemming from diverse conditions such as aging, stroke, or vestibular disorders. Balance rehabilitation is one of a crucial measure to prevent falls and enhance balance function, and one possibility to improve that rehabilitation process is through telerehabilitation. Telerehabilitation allows the utilization of technology to surpass traditional barriers, with virtual coaching systems utilizing augmented reality as a notable approach to guide and motivate patients through exercises. The Virtual Coaching Platform (VCP) implemented within the TeleRehaB DSS system is designed to actively engage patients and facilitate their rehabilitation journey. Leveraging augmented reality, VCP integrates holographic elements into developed exergames and cognitive games to optimize patient experiences. TeleRehaB DSS project employs VCP to deliver home-based training programs for patients with balance disorders, leveraging augmented reality to enhance reality perception by overlaying virtual elements onto the real environment. Developed using Unity, VCP encompasses various exergames and cognitive games, adapting to individual patient needs, thereby creating immersive and engaging scenarios to challenge patients and facilitate treatment. Augmented reality-based virtual coaching systems exhibit substantial promise by providing challenging exercises that encourage regular participation, offering a potential avenue to address balance disorders and enhance patient quality of life. Despite the advantages, it's crucial to acknowledge associated challenges and continue refining augmented reality-based rehabilitation interventions to optimize their effectiveness within clinical settings.

Acknowledgement: This research is funded by the European Union, under the Horizon Europe programme, GA number 101057747 (TeleRehaB project). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the granting authority: European Health and Digital Executive Agency (HADEA). Neither the European Union nor the granting authority can be held responsible for them. Authors also acknowledges the funding by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, contract number [451-03-65/2024-03/200107 (Faculty of Engineering, University of Kragujevac)].

S19 - IFMBE Industry Committee: Medical Technologies - From Concept to Commercialization

Wednesday morning Track C

Jun 12, 10:30 - 12:00

OR-116

Research collaboration between academia, healthcare and industry. Experience from the research profile Embedded Sensor Systems for Health and an adjunct industrial graduate school

Maria Lindén, Mats Björkman

Mälardalen University, Sweden

One of the cornerstones at Mälardalen University, Sweden, is research in close collaboration with society and companies, trying to find solutions to real problems. In 2013, a research profile called Embedded Sensor Systems for Health was established, in which researchers at the university were working in close collaboration with healthcare and industry. The initiative was financially supported by the Swedish Knowledge foundation, Mälardalen University, and in total 20 companies in form of in-kind financing. The focus of the research profile was sensor systems for health monitoring of humans, independent of time and place.

As a result from the profile, the research environment in medical and health engineering at Mälardalen University grew to include 25 people. 5 patents were received, in addition to more traditional academic results, as 50 journal publications, over 160 conference publications, and PhD dissertations. An adjunct industrial PhD school was started with 11 PhD students, which was an excellent way to

perform collaboration with companies, giving the opportunity to understand each other's organization.
Since the research profile has ended 2022, Mälardalen University has initiated a cross-disciplinary center together with several healthcare organizations. In this center, researchers from engineering, health and welfare, organizational research, and innovation and product development come together. The center invites companies for collaboration. Especially, the need from healthcare is in focus, and information driven care has been identified as a main topic. This seems a promising way to continue the work started within the research profile Embedded Sensor System for Health.

OR-117

Innovative ultrasound devices — from research to commercial product

Marcin Lewandowski
us4us Ltd., Poland

Us4us is a spin-out company created in 2015 by academic researchers to commercialize ultrasound solutions for biomed and industrial markets. Our research and OEM ultrasound platforms exploit software-defined ultrasound (SDU) technology. The SDU is a major paradigm shift enabled by GPU-accelerated processing. Today, new innovative ultrasound modalities require access to raw echo data and advanced real-time processing algorithms. Moreover, ML/AI methods may be used to extract even more diagnostic information out of raw ultrasound signals.
Legacy ultrasound scanners implement B-mode imaging and color-flow by applying scan-line acquisition and hardware-based beamforming. Most of the new modalities (elastography, super-resolution imaging, advanced flow, etc.) require ultrafast acquisition and synthetic aperture processing methods. Only a new system architecture and massively parallel processing can stand up to those new techniques.
Traditionally, translating academic research and innovations into a commercial product is a struggle. I will show how our SDU solutions are applied to research and building early demonstrators (proof-of-concept), and later, easy migration to real medical device development. Open software interfaces and high-performance GPU processing open unlimited possibilities for implementation of advanced techniques and ML/AI algorithms. In the first step, a demonstrator can be built using ready-to-use programmable research systems (us4R / us4R-lite). The provided open-source SDK featuring Python/Matlab/C++ interfaces makes it easy to implement custom ultrasound acquisition and processing. Available GPU libraries may provide computation acceleration and integration with ML/AI frameworks required for real-time processing. Next, the demonstrator can be tested and validated in laboratory and/or (pre)clinical environment.
For medical device development, our OEM ultrasound modules are embedded and integrated into the final product. As the very same modules and software are used in the research platforms, the risk of migration is minimized. This strategy enables a fast commercialization path from research, through proof-of-concept, to real medical device development. Today, we work with several start-ups developing innovative ultrasound systems using the presented approach. We are confident that the SDU paradigm implemented on our efficient acquisition/processing hardware can drive future ultrasound developments and device commercialization.

OR-118

Development and commercialization of a novel stimulation device for denervated muscles – challenging under MDD, most likely impossible under current MDR

Winfried Mayr
Medical University of Vienna, Austria

The European R&D-Project RISE, collaboration of 20 European partner institutions, had addressed the special subtopic "denervated muscles / flaccid paraplegia" from basic research to clinical study and transfer to market and clinical application of specific novel stimulation technology. Research under MDD conditions was administratively challenging as even inside the European Community rules of small and large animal research as well as clinical studies deviated, sometimes quite substantially, among different national states and led to increased administrative burdens and delays. Another quite difficult problem occurred, as the electrical charge transfer across stimulation electrodes, necessary for effective muscle activation, had to exceed limitations given in standards for stimulators (IEC 601) significantly. Finally, sufficient solutions

were found, and the project outcome was a validated stimulation prototype and clinical application protocol with proven safety and efficacy, which could be transferred to commercial availability in the form of a certified medical product, which is now stably on the market as efficient problem solver to maintain muscles, after temporary or chronic loss of nerve supply, in healthy physiological state.
On the other hand, a critical look on actual MDR-conditions makes clear, that a similar attempt to develop such a device got kind of unthinkable, beginning with administrative burden and costs for Article 62 and Article 82 studies and strict limitations to harmonized standard in the notification process. Even if all obstacles could be mastered, the cost in relation to the given small market segment made it unrealistic to make such important devices available for patients, who badly need them. Unfortunately, we have already a number sad examples of very useful rehabilitation hardware, available, safe and effective for many years, that got now off the market due to too high recertification costs, like meanwhile more or less all controllable multichannel electro stimulators for movement rehabilitation in paralyzed limbs.
So, we urgently need to reconsider, who much regulation is acceptable, necessary and meaningful to provide best possible patient safety without hindering availability of innovations for best possible medical care, in particular for small target groups. Such developments can lead to unacceptable discrimination of minorities in our society, with particular health related needs, and it is our strong ethical responsibility to counteract and get inadequate regulatory restrictions readjusted within shortest possible time.

OR-119

Navigating Innovational Valleys: Advancing Health Technology Innovation for Sustainable and Affordable Care

Sudesh Sivarasu
University of Cape Town, South Africa

The path to affordable healthcare is fraught with 'valleys of death' a critical chasm in the innovation cycle that often hinder the transition of health technologies from concept to clinical application. Sustainable innovation in healthcare demands not only the reduction of manufacturing costs but also a strategic alignment with the complexities inherent within global health systems. This abstract underscore the need for interventions that support the inception, development, and adoption of appropriate health technologies.
Despite the allure of imported technologies and the seemingly benevolent donation of medical devices, the local compatibility and sustainability of these technologies are often questioned. Dependence on imports neglects the specific environmental and infrastructural idiosyncrasies of low- and middle-income countries. To effectively counter this, the health technology landscape must be reshaped to prioritise solutions that resonate with the context-specific requirements of individual health systems.
The journey towards innovation is further challenged by the prevailing risk-averse climate that stymies local ingenuity. A paradigm shift is necessary to value entrepreneurship within the healthcare technology arena. Successful global models have shown that developing a thriving innovation ecosystem requires a harmonious interplay between academic mastery, public governance, and private sector agility.
Academic institutions emerge as vital catalysts in this innovation ecosystem, nurturing a knowledge pool conducive to research and development while simultaneously anchoring the local industry. The combined forces of academia, public and private sectors are pivotal in bridging the multiple innovation valleys. Together, they can advance tangible business incentives that ultimately promote the broader adoption and implementation of health technologies.
To circumnavigate the valleys of death in innovation, a systemic transformation embracing locally oriented health technology solutions is essential. This change not just fuels affordable healthcare, it also fosters job creation, fortifies the healthcare infrastructure, and most crucially, ensures the relevance and effectiveness of the healthcare solutions to the populations they intend to serve. Sustainable and affordable healthcare is thus a multifaceted endeavour that hinges upon the continuous support and evolution of appropriate health technology innovations.
This abstract discusses the potential of creating such interventions required at various stages of the innovation life cycle of a medical technology.

OR-120

Understanding Regulatory Requirements: A Postmortem Analysis of Tremitas' Bankruptcy in the Medtech Sector

Tibor Zajki-Zechmeister
CommuModo GmbH, Austria

This paper examines the regulatory challenges encountered by Tremitas GmbH, an Austrian startup that developed the Tremipen, a device for quantifying tremor, within the European Union's medical device sector. Transitioning from the Medi-cal Device Directive (MDD) to the Medical Device Regulation (MDR) intro-duced complexities that disproportionately affect startups due to stringent compli-ance requirements. Through a detailed postmortem analysis, we identified critical regulatory missteps by Tremitas, including inadequate understanding of the regulatory framework, mismanagement of clinical trials, and ineffective outsourcing of regulatory activities. These challenges culminated in delayed market entry and contributed to the company's eventual insolvency. Key results indicate that early integration of regulatory knowledge, strategic planning for clinical validation, and careful selection of development partners are essential for navigating the medtech regulatory landscape. The paper underscores the importance of regulatory affairs in the success of medical device startups and suggests that a proactive approach to compliance can mitigate risks and enhance market success. This analysis aims to serve as a cautionary tale and guide for future startups in the medical device in-dustry, emphasizing the critical role of regulatory strategy in entrepreneurial success.

IFMBE Scientific Challenge

Wednesday after lunch
Track B
Jun 12, 13:30 - 14:15

OR-121

A Machine Learning Approach for Predicting Electrophysiological Responses in Genetically Modified HEK Cells

Jacopo Vitale, Martina Sassi, Leandro Pecchia
Università Campus Bio-Medico di Roma, Italy

Electroporation involves exposing biological cells and tissues to pulsed electric fields (PEFs). While these electroporation-based techniques are gaining prominence across various application domains, several studies demonstrated that the electric pulses can affect cell excitability, leading to undesirable effects. However, comprehending the interplay between electroporation and the electrophysiological response of excitable cells poses a significant challenge. In this study, genetically engineered human embryonic kidney (HEK) cells were employed as a simple cell model to investigate the effects of electroporation on excitable cells. These cells were exposed to nine 100μs pulses of increasing electric field strength. The objective of this research is to develop an algorithm for the automatic classification of cell responses. The dataset consists of 2758 binary masks and correlated other experimental information. Three distinct approaches were implemented for cell response classification, namely, a residual network (ResNet), traditional machine learning models, and an hybrid combination of the two. The Nu-Support Vector Classifier, using features extracted from the image contours, exhibited superior performance among all models.

OR-122

Optimizing Electroporation Responses in Genetically Engineered HEK Cells: An Ensemble Learning Approach

Francesco Bassi[1], Simone Kresevic[1], Alessandro Biscontin[2], Aleksandar Miladinovic[2], Milos Ajcevic[1], Agostino Accardo[1]
[1]University of Trieste, Italy
[2]Institute for Maternal and Child Health-IRCCS "Burlo Garofolo", Italy

Use and understanding of electroporation have grown in recent years, revo-lutionizing various fields. However, optimization for stimulation techniques is still needed. In this context, the introduction of genetically modified cell cultures allows a dramatic increase in simulation capabilities, but also intro-duces the necessity of more advanced and human independent analysis methods.
We aimed to identify features, including morphological characteristics and other experimental parameters, to develop models for predicting the responses of genetically engineered HEK (Human Embryonic Kidney) cells to pulsed electric fields.
This subset of predictive features, including the presence of K+ channels, electric field strength, experiment number, initial fluorescence, and cell mor-phology characteristics

was identified.
A machine learning approach based on ensemble learning techniques de-ployed through the XGBoost algorithm was utilized. This approach involves sequentially building numerous weak decision trees, where each subsequent tree aims to correct the errors made by the ones before it. Considering the unbalanced frequencies of the cell response types, we adopted different strategies to balance the training set and avoid bias were adopted.
The produced XGBoost model trained with a combination of real and syn-thetic data exhibited an accuracy of 66.0 %, a mean AUC of 0.89, and an average F1 score of 0.66 when evaluated against the internal test set compris-ing solely real data. Further analysis on an external test set revealed an F1 score of 0.57.
In conclusion, we identified predictive features and produced models that may contribute to predicting the responses of genetically engineered HEK cells to pulsed electric fields.

Cellular and tissue engineering

Wednesday after lunch
Track C
Jun 12, 13:30 - 14:15

OR-123

Decellularized Tissue Engineering Hyaline Cartilage Graft for Articular Cartilage Repair and Its Forward-Looking Test for Space Medicine

Dongan Wang
City University of Hong Kong, Biomedical Engineering, Hong Kong

Articular hyaline cartilage, a tissue articulating skeleton at joints, is highly prone to damages caused by trauma, diseases and ageing; once injured, its self-regeneration is difficult and slow due to the avascular nature. To repair and regenerate damaged articular cartilage, we have innovatively developed a continuous methodology to directly set up a macro-scaled 3D decellularized tissue engineering hyaline cartilage graft (dLhCG). Good osteochondral defect healing and complete integration with adjacent native cartilage in in-situ implantation of dLhCG samples in large animal models demonstrated the competence of dLhCG as a cartilage graft. Investigative clinical trials have been initiated in China and the initial curative effect appears positive. Based on this, for the coming of the Space Age, a forward-looking space experiment is designed and performed with dLhCG for future space medicine. For this purpose, dLhCG samples have been delivered onto Chinese Space Station via Tianzhou-6 cargo spacecraft for a six-month space experiment.

OR-124

Multicomponent printing inks for the designing of 3D extracellular matrix-mimetic biomaterials

Adriana Lungu[1], Raluca Dobrisan[1], Valentina Ciobanu[1], Minodora Marin[1], Sorina Dinescu[2], Izabela-Cristina Stancu[1]
[1]National University of Science and Technology Politehnica Bucharest, Romania
[2]Department of Biochemistry and Molecular Biology, University of Bucharest, Romania

The research interest in 3D printing technologies has increased lately, due to their use in multiple fields, including biomedical applications. Nanocomposite inks are considered a great promise in 3D (bio)printing to fabricate scaffolds that mimic the extracellular matrix (ECM) of the lost tissues. The combination of different types of nano-fillers into a polymeric matrix is a very modern strategy providing biocompatible scaffolds for tissue regeneration.
In the current study, several biomimetic nanocomposite inks were developed by combining two different types of nano-fillers: 1.5-3 % montmorilonnite nanoclays (Cloisite®Na / Cloisite 15A) and cellulose nanofibrils (CNF), embedded within a soft-polymer matrix based on protein-polysaccharide combination. Extrusion printing tests were used to investigate the potential of the nanocomposite hydrogels as 3D printing inks. Some relevant structural, physico-chemical, mechanical and biological characteristics of such scaffolds were defined.
All the 3D printed materials reached their maximum degree of swelling after 24 h of immersion in PBS buffer and then remained in equilibrium (600-700% for samples doped with Cloisite®Na and 500-600% for samples doped with Cloisite 15A). Stability tests were also conducted for identifying product degradation. All the scaffolds exhibited a slower dissolution rate after immersion in PBS and incubated at 37°C (about 20% in 7 days), which could be a sign of the high crosslinked degree of these biopolymer composites

The compositional features of the printed scaffolds were determined using FTIR, whereas the morphology was studied by SEM. The reference materials exhibited an uniform and highly-porous interconnected structures (with large pores of about 100±30 micrometers diameter) , while the incorporation of nanoclays dramatically modifies the morphology. The nanoclay-doped samples present more compact structures with small clusters (about 300 nm) due to the nanoclay agglomeration.
Preliminary in vitro biological tests performed with pre-osteoblast cells revealed optimal biocompatibility of the double nano-reinforced scaffolds. During seven days of culture, the cells tend to proliferate and populate all 3D printed scaffolds, especially Cloisite®Na-enriched scaffolds (MTT cell viability 55%). According to our findings, the double nanostructuration of the inks clearly contributes to the improvement of the cellular component response.
Acknowledgement: This work was supported by a grant from the National Program for Research of the National Association of Technical Universities - GNAC ARUT 2023.

OR-125

Artificial Bone Extracellular Matrices based on 3D-printed nanostructured hydrogels

Adriana Lungu[1], Izabela-Cristina Stancu[1], Elena Olăreț[1], Filis Curti[1], Carmen-Valentina Nicolae[1], Sorina Dinescu[2], Alexandra-Elena Dobranici[2], Bogdan Stefan Vasile[1]

[1]National University of Science and Technology Politehnica Bucharest, Romania

[2]University of Bucharest, Romania

In the current paper we engineered new nanostructured hydrogel precursors for 3D printing, bioinspired from the nanocomposite bone extracellular matrix.
Natural origin hydrogels (based on gelatin, alginate, cellulose, and gellan gum) were used to provide the hydrated matrix in which nanofillers mimicking the mineral phase of hard tissues were added. Paste-like 3D printable inks with different nanofiller loadings were formulated. Calcium carbonate from cuttle bone fragments, wollastonite and biosilica from diatomite were used for their reinforcing effect and for the potential to biomineralize. The scaffolds were characterized through swelling degree, water contact angle, stability under simulated physiological conditions, morphology evaluation, and nanoindentation. The nanocomposite nature was confirmed by scanning electron microscopy (SEM) and micro-computer tomography (micro-CT). In vitro biomineralization was tested. To assess scaffolds' biocompatibility and ability to support osteogenic differentiation in vitro, MC3T3-E1 cell line was used.
Macroporous scaffolds with nanocomposite filaments were obtained. Composition adjustments allowed improved deformation under controlled compression and a modulation of the bulk and surface mechanical behavior, leading to enhanced adhesion of preosteoblasts. Formation of a new mineral phase was detected after cell cultures.
ACKNOWLEDGMENT: This work was supported from the project PN-III-P4-PCE-2021–1240, no. PCE 88/2022.

S20 - System design for biomagnetic applications using optically pumped magnetometers

Wednesday afternoon Track A
Jun 12, 14:15 - 15:30

OR-126

Active compensation for OPM-MEG inside a two-layer magnetically shielded room

Michal Władziński[1], Anna Jodko-Władzińska[1], Tilmann H. Sander[2]

[1]Warsaw University of Technology, Poland

[2]Physikalisch-Technische Budesanstalt Institut Berlin, Germany

Measuring brain responses by magnetoencephalography (MEG) is currently in a hardware development phase since a new type of easy-to-use sensor be-came available. These optically pumped magnetometers (OPM) have many advantages in comparison to the long-employed SQUID sensors, but the re-quirements for magnetic shielding are more demanding. One is the need to compensate for field fluctuations below 1 Hz, which are a consequence of the decreasing efficiency of magnetic shielding towards lower frequencies. Here a cost effective and simple active compensation is developed, which uses a Helmholtz-like compensation coil together with a simple digital Proportional-Integral (PI) controller. The signal from a single OPM is used as the control loop input variable. An

attenuation of 21 dB is achieved in z-direction at 100 mHz ena-bling linear operation of the OPMs. Linear operation is then investigated by measuring MEG while a subject is listening to tones. The experiment is per-formed twice with active compensation OFF and ON and higher auditory M100 amplitudes are observed for the ON condition.

OR-127

Quantitative magnetic nanoparticle imaging with magnetorelaxometry in unshielded environments

Aaron Jaufenthaler, ***Daniel Baumgarten***
UMIT TIROL - Private University for Health Sciences and Health Technology, Austria

Magnetic hyperthermia is a promising technique for tumor treatment. In magnetic hyperthermia, magnetic nanoparticles (MNP) are injected into the tumor and are then heated by applying a e.g. 100 kHz, 20 kA/m magnetic field, leading to tumor regression. However, for a safe and efficient treatment, quantitative spatial imaging is required. In magnetorelaxometry imaging (MRXI), the relaxation of the MNP's net magnetic moment after previous magnetization using pulsed DC excitation coils, is measured with very high sensitive magnetometers, e.g. optically pumped magnetometers. The MNP distribution is then reconstructed by solving an ill-posed inverse problem. Recently, we demonstrated the upscaling of MRXI to the human torso and head inside a magnetically shielded room. In order to enable a broad use of MRXI in clinical settings, the shielding requirements need to be reduced.
Here, we report our first steps towards small-scale unshielded imaging. Our setup is composed of two dual channel optically pumped magnetometers (OMG, Twinleaf), 6 triaxial fluxgate reference sensors, 32 excitation coils, a 3D Helmholtz coil system and a 3D-gradient coil system. The region of interest of our setup is 36 mm x 36 mm x 36 mm and our phantom is composed of gypsum-immobilized RCL-MNP with a clinically relevant iron concentration.
We first use our fluxgate reference sensors and the Helmholtz and gradient coil systems to compensate environmental fields and field gradients. This is needed to optimize sensor performance and to avoid the background-field induced altering of the relaxation behavior of the MNP. The MRXI sequence is then started: The excitation coils are pulsed sequentially for 200 ms, while inbetween each pulse the relaxation signals are recorded for 400 ms. After extensive noise removal, the relaxation parameters are extracted from the measured data and the MNP distribution is reconstructed.
With our setup we were successfully able to reconstruct point-like MNP sources inside the region of interest.
We will discuss the challenges towards unshielded operation of an MRXI setup and present first proof-of-principle reconstruction results. The imaging parameters of our system are currently being investigated.

OR-128

Improved degaussing procedure for a magnetically shielded room

Peter Koss[1], Jens Voigt[2], Allard Schnabel[2], Ronja Rasser[1]
[1]Fraunhofer IPM, Germany
[2]Physikalisch-technische Bundesanstalt, Germany

A series of measurements was conducted to demagnetize a magnetically shielded room (MSR) located at Fraunhofer IPM. The MSR is used for applications such as magnetoencephalography (MEG) and materials testing, which require a low-noise and low residual field environment. To operate optically pumped magnetometers (OPM) inside the MSR, a large volume with a residual field of less than 5 nT is required. Therefore, we aimed to establish an adequate fast and reproducible degaussing procedure.
The MSR at Fraunhofer IPM is constructed out of 2 layers of mu-metal and provides a passive shielding factor for quasi-static fields of above 100. Both mu-metal shells can be demagnetized individually by three degaussing coils. Thus, the MSR has a total of six independent degaussing coils. Each one of the coils encircles the four walls of one MSR shell around one of the three coordinate axes of the MSR.
The residual field in the central 1 m3 was measured on a 25 cm grid at 5x5x5=125 points. When all demagnetization coils are connected in series an overall demagnetization is possible in less than 4 minutes. This configuration still leads to the desired residual magnetic field of <5 nT within the scanned 1 m3 volume.
In this unexpectedly low field region, other influences are no longer negligible. Concerning the field measurement itself, the DC-offset drift of the used fluxgate and the influence of field changes of the environment outside of the MSR observed by a second fluxgate should

be corrected. The obtained field maps revealed weakly magnetic objects in the MSR construction, which must be replaced to obtain significantly lower and more homogeneous residual fields.

OR-129

Full MEG system based on helium OPMs for medical imaging

Rudy Romain, Jaroslaw Rutkowski, Sergey Mitryukovskiy, Kevin Arth, Matthieu Le Prado, Agustin Palacios-Laloy, Etienne Labyt
MAG4Health, France

The first type of Optically Pumped Magnetometers (OPMs) available on the market has represented a technological leap to tackle the drawbacks of SQUID-based MEG systems in terms of cost and adaptability to the subject. A second type of OPM is now available: Helium OPMs (He-OPMs) are sensors using metastable helium-4 atoms as sensitive element contrary to their existing counterparts that use rubidium atoms. As a consequence both sensors have different functioning principles and thus have their own advantages and limitations. MAG4Health develops MEG system based on helium OPMs and aims to democratize the use of MEG by making it more cost-effective and expand its range of usability. A standard system consists in a set of 48 sensors, a flexible helmet, and a control unit driving the sensors and running an acquisition software. He-OPMs operate at room temperature, they can then be placed in direct contact with the subject scalp and can be used for extended period of time. They operate in a 3-axis closed-loop mode making their dynamic range virtually unlimited (current electrics compensation up to 300 nT), which release by a great deal the specification on the magnetic shielding room. In addition, their bandwidth of 2 kHz makes it possible to record fast brain activities. The sensor principle leads to a vectorial measurement with 2 axes more sensitive than the third one. The sensitivity of this two axes (radial and tangential to the scalp) are below 40 fT/rtHz. This figure is larger than their alkali counterparts is counter-balanced by the closer proximity to magnetic sources within the brain, leading to an overall similar signal-to-noise ratio to alkali OPMS and better than SQUIDs. He-OPMs have been developed for space exploration at CEA (French Technological Institute) and have been used in the SWARM mission commissioned by ESA (European Space Agency) for about 10 years, proving the sensors' reliability and robustness. The sensors are placed on a flexible helmet with about 90 different sensor positions allowing for a whole-head configuration or denser arrays. The system computer includes a visualisation and acquisition software allowing the user to display and record data in real time. The system produces files in an fiff-like format widely compatible with common data processing tools. The prototype based on 5 He-OPMs have been used in various contexts (epilepsy recordings, somatosensory and visual tasks, and magnetocardiography). First results using the full 48-sensor system will be presented.

OR-130

Full OPM-MEG system with limited sensor counts

Urban Marhl[1], Rok Hren[1], Tilmann H. Sander[2], *Vojko Jazbinšek*[1]
[1]Institute of Mathematics, Physics and Mechanics, Slovenia
[2]Physikalisch-Technische Budesanstalt Institut Berlin, Germany

Magnetoencephalography (MEG) is a non-invasive functional imaging technique for measuring weak magnetic fields generated by electrical currents in the brain. Standard MEG system is using a superconducting quantum interference device (SQUID). These systems need expensive cooling and have a fixed, large array of sensors to measure MFMs (magnetic field maps) around the whole head. As an alternative, OPMs (optically pumped magnetometers) operate at room temperature and can be placed individually much closer to the head surface. In the standard SQUID-MEG recordings, we typically encounter the problem of redundancy and uniqueness of signal information contained in a dense array of sensors covering the whole head. In this study, we explored the possibility of obtaining most of the relevant information using OPM-MEG with limited sensor counts. We employed an iterative statistical technique (IST), previously developed for body surface potential mapping, on large data sets of whole-head MEG measurements of audio-evoked fields (AEFs) to select an optimal subspace of recording sites and to determine a transformation matrix, which projects measurements from selected to unselected sites to estimate the full MFM. Since we have not had enough OPMs yet to measure whole-head OPM-MFMs, we employed a database of 18 SQUID-MEG AEF

measurements and project it to both radial and tangential components of the magnetic field on 80 OPM measuring sites close to the head surface using current distribution on the brain surface obtained by MNE (minimum norm estimation) from measured SQUID-MFMs. We have tested IST on various protocols, like using the whole head MFMs or only one hemisphere, measuring only one component or a combination of both. We calculated measures like correlation coefficient (CC), root-mean-square and relative errors to evaluate the quality of full MFM estimated from optimally selected measuring sites. Additionally, we checked source localization errors for the largest audio response (M100) by calculating equivalent single current dipole for the one hemisphere or dual current dipoles for the whole head M100-MFMs. In all cases, we found that most of the information content is in the first 15 to 20 optimally selected measuring sites (CCs>0.95, localization errors < 1 mm). The main finding of our study is that for event-related fields, like AEF in this study, which have mainly focal origin, a markedly smaller number of recording sites, in comparison to that currently employed in systems for MFM recordings, may be sufficient to extract relevant information.

S28 - BME Education in Europe

Wednesday afternoon
Track B
Jun 12, 14:15 - 15:30

OR-131

Overview of the BME study programs – previous European wide survey results

Nicolas Pallikarakis
Institute of Biomedical Technology (INBIT), Greece

It is widely accepted today, that modern health care delivery is the outcome of the progress made in biomedical engineering. An indicator of this fact is the continiously growing number of universities offering BME studies at all levels: BSc, MSc and PhD. Three surveys performed by INBIT give a general view of this evolution. The first one under the EU funded MELETI Project (Medical Engineering Listed Education & Training Information) in 2000, found 67 programs that were offered by 50 Universities in Europe: 33 undergraduate (BSc) and 34 postgraduate (MSc and PhD) programs. The second performed in 2010 under the Erasmus/Tempus IV, CRH BME (Curriculum Reformation and Harmonization in the Field of Biomedical Engineering) project, revealed that this number was almost triple. A more recent survey was performed by INBIT in 2019, in collaboration with EAMBES. In 40 european countries included in this survey, 346 BME study programs were identified in total, offered by 184 Universities in 31 countries. 115 BSc, 161 MSc degree and 60 PhD degree. An important factor that should be taken into consideration is the content of programs offered since the title alone could be misleading. Similar growth as in Europe, is expected for most of the other world regions and the worldwide survey under preparation by IFMBE, that is joined by INBIT.

OR-132

EU students, teachers and researchers exchange programs

Ratko Magjarević
University of Zagreb, Croatia

In recent years, BME and BME education have been influenced by two major factors: the transition of health care to digital health care and the significant impact of the pandemic on the way of teaching in general, including in BME. In this session, we would like to explore how these factors influenced on core BME curricula, interdisciplinary topics, discipline-specific sub-specialties, and students' capacity for problem solving and communication. As a reference, we use the Tempus project on BME education in Europe conducted a decade ago.

OR-133

The CRH-BME Tempus project – results and experience a decade after

Tomaž Jarm
University of Ljubljana, Slovenia

Historically, the origins of Biomedical Engineering (BME) at our school (University of Ljubljana, Faculty of electrical engineering; UL-FE), date back to the late 1960s. BME was first introduced into a formal undergraduate study program in 1977, as a specialty subtrack Cybernetics in Medicine within one of four major study tracks under the umbrella of Electrical Engineering, called Control Engineering. About 3 decades later the running of European Tempus Project CRH-BME coincided roughly with the formation of the new Department of BME at UL-FE and the Bologna reform of the 1st and 2nd (Masters) level

study programs at our school, resulting in a new Masters-level study program of Biomedical Engineering, which was run for the first time in the academic year 2012-2013.
Our study program of BME was rooted in the earlier program, but it was also influenced by the CRH-BME Tempus Project, of which we were an integral part. In the formation of our study program, we followed the recommendations arrived at during the duration of the Project in terms of the number of credits allocated to different categories of courses and in inclusion of specific courses in the program that covered in sufficient quantity and quality the so called "core" BME topics, recognized in the CRH-BME recommendations as being essential for any BME study program. But at the same time, our curriculum also included special topics reflecting the long tradition and expertise in the field of BME which existed and continues to be developed in research groups at UL-FE.
Over the last 11 years, the study program of BME has established itself as a stable study track, one of 7 tracks that currently make up the Masters-level study program of Electrical Engineering at UL-FE. Except for a couple of shared elective courses, the program of BME has its own curriculum and courses. The total number of students enrolled in the whole Masters-level study program is 120 per year (after the entrance exam), and the BME track attracts on average about 15 students per year. Even though the majority are the 1st level graduates of Electrical Engineering at our school, we also attracts 1st level graduates of Physics, Mechanical Engineering, Chemical Engineering and from Biotechnical Faculty. The curriculum remains largely unchanged in terms of courses, but the topics included in the courses reflect the changes and rapid development of new technologies that inevitably affect the field of BME.

OR-134

BME in EC research projects

Leandro Pecchia
Campus Bio Medico University of Rome, Italy, Italy

Abstract was not received.

OR-135

Ethical Engineer: Enhancing AI Education in Engineering

Lenka Lhotská, David Macku
Czech Technical University in Prague, Czech Republic

The Erasmus+ project Ethical Engineer aims to enhance AI education by promoting Trustworthy AI in Europe, emphasising ethical, social, and legal aspects in engineering education and training. Focusing on higher education engineering and robotics students, we seek to instil ethical principles in AI development. Our goal is to empower future AI experts to create systems aligned with European values, ethical guidelines, and societal well-being. In the Ethical Engineer project, the work is divided into 4 activity-based WPs: Develop Case Studies & Starter Kit: providing AI-focused educational materials; Establish Problem-Based Learning OERs: creating flexible, interactive open resources; Initiate Ethical Engineer Bootcamps: offering immersive, interdisciplinary learning; Engage in Sharing & Sustainability: leveraging networks and enhancing project presentation. The project will produce the following outcomes: An Ethical AI Case Studies & Starter Kit, to teach engineering students about the ethical implications of their work; Ethical Engineer OERs, flexible open education resources based on real-world case studies that lecturers can use to teach AI & Robotics Ethics in their programs; Bootcamps, an interdisciplinary approach to teaching ethical considerations in AI to students that will be systematised in a guide for others to replicate.

The project aims to target four groups: ENGINEERING STUDENTS - Undergraduate and graduate students enrolled in engineering and robotics courses need to be equipped with the ethical knowledge and skills necessary to navigate the ethical challenges posed by AI and robotics technologies. ENGINEERING PROFESSORS AND LECTURERS - Many professors and lecturers in engineering faculties have varied experiences and knowledge of ethics in practice. While they may be well-versed in the technical aspects of AI and robotics, they require evidence-based approaches and proof of effectiveness before investing their time in new practices that integrate ethical considerations into their teaching. LEARNING/EDUCATION SCIENTISTS - Academics and practitioners whose interest lies in the study of education and the improvement of instructional methodologies for more effective learning and teaching. Their shared interest is the use of innovative methodologies to improve competence development within traditional academic courses. AI ETHICS EDUCATION STAKEHOLDERS - The project is of dir-

ect relevance to national education authorities, networks of HEIs and membership associations interested in improving AI Ethics education.

Our project seeks to fill a gap in engineering education by integrating ethical considerations into the development and deployment of AI and robotics technologies. This project has the potential to make a significant contribution to the development of engineers who are not only technically proficient but also ethically responsible and able to navigate the complex challenges posed by AI and robotics technologies.

BME Miscellaneous topics

Wednesday afternoon
Track C
Jun 12, 14:15 - 15:30

OR-136

M-Health in Prostate Cancer: Professional and Patient Perspectives

Petra Hospodková, Irina Klubarská, *Matyáš Mašek*, Martin Budil
Czech Technical University in Prague, Czech Republic

In the current study, an analysis of mobile health (m-health) technology usage in managing prostate cancer, focusing on patients undergoing radiotherapy, was conducted. Amid increasing incidence and mortality rates of prostate cancer in the Czech Republic, exploring m-health potential in oncological care is of critical research interest. The aim was to identify the benefits of m-health in radiotherapy, assessing current market dynamics and stakeholder roles to inform the conceptualization of future m-health application devel-opment in oncology. A qualitative approach utilizing semi-structured interviews (using software MAXQDA 22) with patients and medical staff was employed to gain deeper insights into personal experiences and preferences regarding m-health applications and devices. The analysis showed limited patient engagement with m-health technologies; some were interested in health monitoring, while others were worried about complexity and usability. Medical professionals recognized m-health's potential in treatment optimization but noted integration and data security challenges. In conclusion, m-health represents significant potential for innovation in prostate cancer patient care. However, addressing existing challenges, including ensuring user-friendliness, effective integration into healthcare systems, and protecting personal health data, is imperative. These findings provide an overview of the current state and outline potential trajectories for future development and implementation of m-health in oncology.

OR-137

Research on dental materials for their suitability in building anthropomorphic phantoms

Nikolay Dukov, Minko Milev, Todor Todorov, Zhivko Bliznakov, Kristina Bliznakova
Medical University of Varna, Bulgaria

The main goal of the study is to investigate materials from dental practice and assess their suitability for manufacturing anthropomorphic phantoms designed for X-ray imaging modalities. For this purpose, we investigated nine commercial materials commonly employed in dental procedures for tasks such as restoration, duplication, and imitation. They underwent scanning at a clinical Computed Tomography (CT) facility using six anode voltages. Subsequently, we measured their CT numbers, expressed in Hounsfield Units (HU). The findings of our investigation indicate that three specific materials, namely Temp silic, Gingifast Elastic, Ellite Double A, exhibit promising characteristics for the production of anatomically accurate bone structures in anthropomorphic phantoms.

OR-138

Analysis of redox processes from in silico perspective in colorectal cancer cell line

Milica Nikolic[1], Nevena Milivojevic Dimitrijevic[2], Ana Miric[2], Marko Zivanovic[2], Nenad Filipovic[2]
[1]Steinbeis Advanced Risk Technologies Institute Kragujevac, Serbia
[2]University of Kragujevac, Serbia

Oxidation and reduction processes (redox) are essential for the proper functioning of healthy cells, where the environment creates a prooxidant-antioxidant balance. Disturbance of this balance, such as the increase of oxidative stress due to the reduction of antioxidant systems, leads to pathological changes in cells and disease occurrence, including cancer. Glutathione (GSH) is an antioxidant capable of preventing damage to cellular components caused by reactive oxygen species

(ROS), such as superoxide anion radical, hydroxyl radical and hydrogen peroxide. GSH protects the cells by neutralising ROS in a way that it changes form from reduced (GSH) to an oxidised state (GSSG). The final maintenance of the ratio between GSH-GSSG is a key factor in the defence of the cell from exposure to oxidative stress and oxidative damage. Colon cancer cells (HCT-116) with disrupted balance of prooxidative-antioxidative systems can be treated with noble metals to recover the environment of healthy tissues. In this research, two types of gold complexes were applied to study in vitro the disruption of the redox balance in colorectal cancer. In silico models were developed in the first phase to replicate experimental observations and provide a good matching of the results (validation). In the second phase in silico models were used to predict temporal responses, by creating a fitting curve, and to perform sensitivity analysis to highlight the influence of each component in the determined molecular mechanism of oxygen reactions, including the antioxidant enzymes' role. Estimation of GSH-GSSG ratios in time was based upon the implementation of the bi-bi mechanism for enzymes. The mathematical model was created and solved in Matlab commercial software. The responses were collected for cases when gold complexes were not applied (control group) and when different concentrations of gold complexes were applied during the first 72h. Used concentrations of gold complexes were 0.1, 1, 10 and 50 [M]. Calculated errors revealed that the range of predicted and experimental values have the same order of magnitude. Cytotoxicity results revealed the significant influence of one gold complex, especially at a concentration of 10 M and higher, causing a higher production of free radicals and cytotoxic effect on the cancer cell line, which is confirmed by in silico results as well.

Acknowledgement: This research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, contract number 451-03-66/2024-03/200378 (Institute for Information Technologies Kragujevac, University of Kragujevac) and TOXBOX H2020 project, ID:101138387, 2024-2028.

OR-139

Modeling the conductive characteristics of the human lower back using medical imaging and FEM modeling to optimize tSCS therapy

Jón Andri Árnason, Ragnhildur Guðmundsdóttir-Korchai, Þórður Helgason
Reykjavík University, Iceland

Transcutaneous spinal cord stimulation (tSCS) is a promising non-invasive therapy for managing chronic pain and enhancing motor function in individuals suffering from spinal cord injuries (SCI). The precise mechanisms of tSCS are currently not fully understood with the medical modality suffering from being highly patient-specific with differences in patient body composition needing to be accounted for with electrode placement and current intensity.

The purpose of this research project is to provide some insight into the distribution of electric current within the human body by developing a novel process of creating a Finite element model (FEM) of the human body using CT images. High-resolution CT images were taken of the lower ventral body cavity. The images were then imported into Materialize Mimics where a 3D model was created for each major structure e.g. skin, fat, muscle, skeleton, spinal cord, etc. The 3D models were pre-processed in Autodesk Meshmixer to remove any unwanted geometry. The 3D models were imported into Ansys SpaceClaim where the models were converted into solid CAD objects. There each organ model was recombined to create a single model of the human lower ventral body cavity. The completed model was then imported into Ansys Maxwell 3D to be solved.

Five simulations were performed. Four of those simulations had the cathode electrode at T10, T12, L2, and L4 and the anode electrode fixed at S2. The fifth simulation had electrodes at all previous placements, but the stimulation was introduced through the T10 electrode. The simulations took on average 47.4 hours.

The simulation results conformed to the currently understood pattern of current density distribution during TSCS with a measurable difference in electrical current density of the spinal cord depending on electrode position. The T10 to S2 configuration had the highest density in the spinal cord with L4 to S2, being the lowest.

This simulation method, utilizing Ansys Max-

well, has the benefit of easily changing the electrode configurations, as is useful to target specific areas for high electrical current densities, but suffers from long simulation times and undesirable mesh densities. Future work can be used to reduce simulation time and validate the process.

OR-140

Assessing Ergonomic Compliance in Industrial Environments with Markerless 3D Camera-Based Systems

Jindřich Adolf[1], Ilona Kačerová[2], Kateřina Jurčová[3], Vladimíra Lipšová[3], Jaromír Doležal[1], Lenka Lhotská[1]

[1]Czech Technical University in Prague, Czech Republic

[2]State Institute of Health, Czech Republic

[3]Occupational Safety Research Institute, Czech Republic

In this research, we introduce a markerless, 3D camera-based system for ergonomic assessment in industrial settings, utilizing two standard RGB cameras and the OpenPose framework for real-time 2D skeleton mapping. This novel approach overcomes the limitations of traditional, subjective ergonomic assessment methods and sensor-based systems by offering objective posture evaluations without physical markers. The dual-camera setup enables accurate 3D reconstruction of worker movements. Our feasibility study validates the system using the Intraclass Correlation Coefficient (ICC), achieving a ground truth agreement among ergonomic experts with an ICC of 0.97, and the Pearson Correlation Coefficient (PCC), demonstrating a strong correlation (PCC of 0.81) between expert evaluations and our camera-based measurements for neck and upper limb flexion. This highlights the system's reliability and potential as a cost-effective solution in industrial ergonomics.

S14 - Non-invasive methods for monitoring electrophysiological and hemodynamic brain activity

Wednesday late afternoon
Track A
Jun 12, 16:00 - 18:00

OR-141

Difference in Mentalizing Function between Face-to-Face and Online Communications

Joohyeong Kim, Hayato Watanabe, *Koichi Yokosawa*

Hokkaido University, Japan

Coronavirus disease 2019 triggered the worldwide spread of online communication tools such as Zoom, which are now used for meetings, classes, and interviews. It has been reported that long-term online communication can induce a psychological disorder (so-called Zoom fatigue), suggesting differences between online communication and face-to-face communication. During communication, mentalizing functions are engaged, referring our ability to understand ourselves and others in terms of intentional mental states, such as feelings, desires, and attitudes. Therefore, in the current study, we investigated whether mentalizing function differs between online and face-to-face communications. Magnetoencephalograms were recorded while participants engaged in a question-and-answer dialogue either in face-to-face or online conditions. Amplitudes of spontaneous brain rhythms, alpha-, beta-, and theta-bands were compared in 16 brain regions which have been reported to be involved in mentalizing function. Significant differences were observed only in the theta-band rhythm. Normalized amplitudes in the right temporo-parietal junction and the right anterior temporal lobe were significantly lower, and those in the right posterior rostral frontal cortex were significantly higher in the online condition compared with those in the face-to-face condition. These results suggest that low visual reality (or visual information context) and reduced attention (eye-contact) in online communication modulate mentalizing function.

OR-142

Track-EP: A Semi-automated Tool for Enhancing Interictal EEG Interpretation

Margherita Anna Grazia Matarrese[1], Simonetta Filippi[1], Leandro Pecchia[1], Christos Papadelis[2]

[1]Campus Bio Medico University of Rome, Italy, Italy

[2]Jane and John Justin Institute for Mind Health, Neurosciences Center, Cook Children's Health Care System, United States

Inspecting epileptic activity in EEG recordings can be time-consuming for clinicians, especially when recordings are performed with a high number of channels. Identifying the

epileptogenic zone (EZ) –the area responsible for causing seizures– can be difficult and relies on the integration of several diagnostic tests. Typically, clinicians identify the channels that record multiple stereotyped seizures as the EZ. However, seizures are unpredictable and may not occur during monitoring. Therefore, interictal biomarkers, such as spikes (1-70 Hz) or ripples (80-250 Hz), recordable in the period between seizures, can be used to approximate the EZ. Intracranial EEG (iEEG) studies show that spikes and ripples propagate over time and that the onsets of these propagations (spike-onset and ripple-onset) are more specific to the EZ than the areas of spread. Yet, their definition is challenging. Here, we aim to present a semi-automated pipeline, Track-EP, that can assist clinicians in identifying these areas in clinical EEG data, comprising iEEG and scalp-EEG recordings. Track-EP streamlines the visualization and analysis process and can track the onset and propagation of interictal activity for spikes and ripples.

Utilizing custom MATLAB® detectors, spikes and ripples are automatically identified on each channel using filtered data in the specified frequency band. Subsequently, an automated algorithm categorizes them to define their temporal occurrence and extracts the time position of the first channel, showing that biomarker. We reconstruct cortical and scalp surfaces from the patient's MRI and compute a Boundary Element Model (BEM) as forward problem estimation. We localize spike/ripple propagation patterns and onset regions in the source domain with dSPM using a time-sliding window approach. We further validated the spike-onset and the ripple-onset areas by comparing them with the clinically defined EZ.

Track-EP generates color-coded volume-based visualizations in the patient's MRI space by reconstructing spike/ripple propagation. The visualization ranges from red to blue, where red volumes represent the brain regions that initiate spike/ripple propagation, while blue volumes indicate those that occur later in the propagation. Track-EP then dichotomizes brain area involved in propagation as either onset or spread areas. Finally, we found that spike-onset and ripple-onset areas overlap with the EZ more than areas or spread.

This integrated methodology may aid presurgical evaluation, offering an efficient, reliable, and objective interpretation of iEEG and scalp-EEG recordings. It also provides two additional EZ approximations that can be used to shorten and improve surgical planning.

OR-143

The Neuromodulation Evaluation with Functional Near-Infrared Spectroscopy for Transcutaneous Auricular Vagus Nerve Stimulation on Upper Extremity Rehabilitation

Chien-An Chen[1], Jia-Jin Chen[1], Wei-Cheng Sun[2], Chao Chen Lo[2]

[1]National Cheng Kung University, Taiwan

[2]Shu-Zen Junior College of Medicine and Management, Taiwan

The preliminary evidence suggests that VNS and rehabilitation training must be precisely coordinated in time to produce rehabilitation effectiveness. Several benefits taVNS with rehabilitation have been illustrated , such as:(1)Recovery of motor function, it has been observed that intervention with taVNS leads to a significant improvement in various clinical assessments such as Fugl-Meyer and WMFT scores, and these improvements are maintained or further enhanced in subsequent follow-ups. (2)Reduction of muscle tension: there is a more significant improvement in muscle tension in the wrist and hand muscles compared to the control group. (3) Restoration of sensory function: There are also significant differences in sensory function for individuals receiving taVNS. This may contribute to a positive feedback loop for both motor and sensory recovery, ultimately promoting neuroplasticity. Whether the mechanism of the taVNS for rehabilitation modulation remains unsupported by research.

In our previous study, the functional near infrared spectroscopy(fNIRS) monitoring during active or passive pedaling exercise found that during passive pedaling exercise, activation in the sensorimotor cortex, supplementary motor area, and premotor cortex was similar to that during active pedaling exercise without physiological feedback, but the activation level in the contralateral supplementary motor area was smaller. Furthermore, in active pedaling training with physiological feedback, there was a reduction in speed variation, an increase in EMG symmetry index, and an increase in activation of the premotor cortex. These findings support that physiological feedback helps people to self-regulate muscle strength and achieve neuromodulation effects.

In this study, to evaluate the neuromodulation

effect of taVNS on motor rehabilitation. The upper limb pedaling exercise is selected as the motor task. Pealing serves both as a method of physical conditioning and as a method of rehabilitation exercise. The participants was asked to maintain the certain speed by the visual feedback. The taVNS was conducted during the motor task for 10 minutes. The electrodes were placed at the left ear on cymba concha, cavum concha, and tragus. The continuous theta burst stimulation (cTBS) waveform is selected which is validated in previous study. The initial standard intensity of taVNS was set to 1000uA, and adjust to maximum individual subject tolerance. The EMG on the biceps and triceps on both arms and the fNIRS on primary motor cortex is monitored during the whole session. The symmetry of the EMG and fNIRS was compared before and after the intervention. The activation mapping of hemodynamic response difference was reported in the SMC,SS and PMC. The result shows taVNS as the potential tool for motor rehabilitation.

OR-144

Can fNIRS be used as a treatment monitoring tool for Alzheimer's disease?

Samaneh Azarbarzin, *Zahra Moussavi*
University of Manitoba, Canada

Functional near-infrared spectroscopy (fNIRS) is a non-invasive technique used to measure brain activity by monitoring changes in blood oxygenation levels. In this study, we investigated whether fNIRS can be used as a monitoring tool to explore the effect of transcranial alternating current stimulation (tACS) treatment on cognitive function of people with Alzheimer's disease (AD) in a cross-over designed study. Data of 27 individuals with AD who finished the study, were analyzed. Study participants received real/sham tACS paired with cognitive exercises for two 20-min sessions/day, 5 days/week for 4 weeks; there was 2-5 months washout period between the two treatment blocks of the study. An eight-channel fNIRS device was utilized to measure blood oxygenation levels in the prefrontal cortex before and after each treatment block, during a mental task. Compared to baseline, results show a greater reduction of oxyhemoglobin levels at post-intervention for real tACS compared to sham. Patients with AD often exhibit increased oxygen consumption during cognitive tasks as compensation. As most of our participants improved with real tACS, we expected to see such a decrease in oxygen consumption after the real intervention. Thus, the results highlight fNIRS potential in evaluating the effectiveness of tACS treatment on people with AD.

OR-145

Multiparametric measurement of cerebral blood flow in neurointensive care

Karin Wårdell[1], Sofie Tapper[1], Stina Mauritzon[1], Fredrik Ginstman[2], Peter Zsigmond[2]
[1]Linköping University, Sweden
[2]Linköping University Hosptial, Sweden

Measurement of cerebral blood flow in the neurointensive care unit (NICU) is challenging and most available techniques give indirect measures or provide snap-shot information. Both the micro- and macro blood flow components should ideally be captured over time and space and be visualized in real-time at bedside. Our research group moves towards this goal by setting up a concept combining laser Doppler flowmetry (LDF) with magnetic resonance imaging (MRI). The aim was to present the first examples of this multiparametric approach on patients being monitored in the NICU after suffering subarachnoid hemorrhage (SAH).

An LDF system (Perimed AB, Sweden) and related in-house developed software and fiber-optical probes were adapted for clinical use as previously described [1]. The flexible probe was implanted in relation to routine surgery in seven patients (EPN 2018/322-31). In the NICU, LDF data was recorded meanwhile patient movements and care were monitored together with routine parameters. At Linköping University Hospital, a 3T MR system (Siemens Healthineers, Germany) is available at the NICU for use together with the LDF system. Simultaneous LDF and MRI measurements were performed in one SAH patient. The MRI protocol included T1- and T2 weighted imaging, 2D flow measurements in larger cerebral arteries, and perfusion imaging using pulsed arterial spin labeling (ASL). MRI measurements were performed on day 6 and 8 after the initial hemorrhage. Analyses included calculation of the total inflow to the brain, quantification of ASL maps using an openly available flow territory atlas [2], and inspection of LDF recordings.

A clean LDF signal, with artifacts noted < 5 % of the total time, was acquired for up to 10 days of monitoring in the NICU. Also, during MRI

the LDF signal quality was stable and without distortion nor interference from movement artifacts. With the LDF kept in the control room, a 5m long cable passed through a hole in the wall to the patient, which made the recording safe from an MR perspective. The tip of the probe was visible in the T2 images and did distort the image quality in the vicinity. MRI showed a reduction of the cerebral flow between the two measurement days, both seen globally and regionally. As a next step, a multiparametric comparison between macro and microcirculatory parameters will be done, and more patient data collected.

References:
1. Mauritzon, S., et al., Front Neurosci, 2022. 16
2. Liu, C.-F., et al., Scientific Data, 2023. 10(1)

OR-146

Measuring Anxiety Quantitatively in a Depression population

Zahra Moussavi, ***Brian Lithgow***
University of Manitoba, Canada

Electrovestibulography (EVestG) has been applied to Bipolar Disorder and Major Depressive Disorder patients each divided into those with Anxiety Disorder and those without. EVestG is a recording of vestibulo-acoustic activity from the external ear canal. It incorporates a complex wavelet analysis of phase across 6 bands. Fifty Bipolar (26 with Anxiety Disorder) and 42 Major Depressive Disorder (24 with Anxiety Disorder) were analysed. Differences in a frequency component within the Hippocampal Theta frequency range as well as an asymmetry between left and right-side recordings in this same frequency band were characteristic of Anxiety Disorder in both populations. Whilst the presentation of additional spectral energy components within the Hippocampal Theta frequency range were representative of Anxiety Disorder they are not identical for Bipolar Disorder and Major Depressive Disorder. The results indicate comorbidities such as Anxiety within a Bipolar or Major Depression population can impact classification accuracy as well as treatment efficacy. Further, they highlight the need for measuring treatment efficacy for both the pathology and comorbidity.

OR-147

Data processing and visualization for multimodal imaging of neuro-vascular coupling

Stanislaw Wojtkiewicz[1], Urban Marhl[2], Piotr Sawosz[1], Vojko Jazbinšek[2], Tilmann H. Sander[3], Adam Liebert[1]
[1]Nalecz Institute of Biocybernetics and Biomedical Engineering, Poland
[2]Institute of Mathematics, Physics and Mechanics, Slovenia
[3]Physikalisch-Technische Budesanstalt Institut Berlin, Germany

The neurovascular coupling (NVC), a mechanism linking neuronal activity with vascular responses, is crucial for understanding brain function. Methods like functional resonance imaging (fMRI) offer an insight on the vascular response. Combination of electroencephalography (EEG) and functional near-infrared spectroscopy (fNIRS) can provide a more comprehensive view to the NVC. This study introduces a multimodal approach to image the NCV utilizing magnetoencephalography (MEG) combined with the fNIRS, implementing recent advancements in fNIRS imagers and optically pumped magnetometers (OPM). Unlike standard MEG systems (SQUID magnetometers) requiring cryogenic cooling, OPMs offer portability and enhanced signal-to-noise ratio, enabling imaging during natural tasks.

The aim of this study is to provide a spatial distribution of the neurovascular coupling efficiency and develop tool for neurophysiological research and clinical medicine.

Data is registered using 15 OPMs (QuSpin, USA) and in-house developed, high-dynamic range fNIRS capable of high-density optical diffuse tomography. Optical signals are registered using 15 source fibres and 9 detection fibres fixed above the motor cortex of a healthy subject resulting in 135 source-detector pairs working simultaneously at two wavelengths: 750 nm and 850 nm. Both OPMs and fibres are mounted within the same space using a 3D-printed and subject-specific helmet. The experiment is carried out in a magnetically shielded room (the single most magnetically-shielded room on Earth located at the PTB in Berlin). The protocol involved right hand ball squeezing followed by rest periods, synchronized across both modalities: MEG and fNIRS.

Data processing included MEG preprocessing using FIR filtering and independent component analysis and at the fNIRS side in-

tensities conversion to haemoglobin changes with the modified Beer-Lambert law. Further, a block averaging is carried out to denoise the NVC responses. Results on healthy volunteers show a visible delay (˜8 s) between fast MEG and slower fNIRS responses. Here we propose a method of topographical visualization of both modalities. Further, we propose a method of spatial visualization of the NVC parametrized with a slope between the vascular (fNIRS) and the neuro (MEG) responses.

This study introduces the approach for understanding neurovascular coupling dynamics. By leveraging advanced imaging techniques, it offers insights into the complex relations between neuronal activity and vascular responses, with implications for studying brain function and pathologies.

OR-148

Applying near infrared spectroscopy for assessment of anxiety

Chien-An Chen[1], BO-TSEN Lin[1], Yi-Jing Huang[2], Yu-Jui Huang[3], Pao-Huan Chen[3], Jia-Jin Chen[1]
[1]National Cheng Kung University, Taiwan
[2]National Taiwan University, Taiwan
[3]Taipei Medical University Hospital, Taiwan

Studies have found that people with higher levels of anxiety have asymmetric hemodynamic responses in the dorsolateral prefrontal cortex (DLPFC) on both hemispheres. This lateralization phenomenon is one of important indicators of anxiety disorder which can provide quantitative assessment of anxiety as well as for homecare neurofeedback scheme. Functional near infrared spectroscopy (fNIRS) provide noninvasive brain image approach to monitor the brain activity based on the neurovascular coupling. Currently, clinical studies have shown the efficacy using fNIRS for the assessment of anxiety disorders. Studies have found that the index of social anxiety and depressive rumination in adolescents is significantly negatively correlated with the hemodynamic response of the cognitive control network in the frontal lobe. In general anxiety-related research, the lateralization index is used as one of the indicators to evaluate the degree of anxiety during experiment of subjects facing threats. The aims of this study are to explore the utilization of fNIRS recordings from relevant brain areas to understand neural mechanisms and neuromodulation of anxiety disorder.
To assess the anxiety level, the cerebral hemodynamics measured by fNIRS during cognitive task from generalized anxiety disorder (GAD) patients and healthy subjects was processed. A total of 25 subjects and 34 healthy adults were recruited in this study. All the participants were instructed to finish 4 cognitive tasks including verbal fluency, N-back, Go or No-Go and Serial Subtraction tasks. The optodes placements of fNIRS were covered the ventromedial PFC and DLPFC on both hemispheres. The hemodynamic response in both time and frequency domains including lateralization index calculation, inter-hemispheric correlation, and wavelet phase coherence were adopted in this study.
Our study showed that the blood oxygen concentration required by the prefrontal cortex under the cognitive task of GAD patients was higher than that of healthy adults indicating that the cognitive task has a greater cognitive burden on GAD patients. This implies that severe GAD patients have poorer prefrontal lobe function. In addition, the time-frequency domain analysis based on wavelet transform indicating a significant energy change in extremely low frequencies band observed from high-anxiety patients during tasks compared to the resting state. This phenomenon was not observed in healthy subjects. In summary, our study of limited population showed that fNIRS has the potential to be used as an assessment tool for anxiety symptoms. The future adaptation of customed made NIRS system can be used for evaluation of brain neuromodulation as well as for neuro-biofeedback training for subjects with GAD.

S25 - IFMBE Education in BME: BME Education in Latin America and BME in Africa

Wednesday late afternoon Track B
Jun 12, 16:00 - 18:00

OR-149

ARCUSUR SYSTEM: supporting the way to accreditation programs

Virgina Laura Ballarin
IFMBE AC Member - National University of Mar del Plata, Argentina

In 1991 the MERCOSUR Education Sector created the Meeting of Ministers of Education of the member countries of MERCOSUR (MER)

as the entity responsible for the coordination of education policies in the region. In June of 1998, in Buenos Aires, the MER approved the Memorandum of Understanding on the Implementation of an Experimental Mechanism of Accreditation of Careers for the Recognition of University Degrees in the MERCOSUR Countries. Advisory Commissions on Agriculture, Engineering and Medicine, produced the documents "Dimensions, Components, Criteria and Indicators for the Accreditation of MERCOSUR" in their respective areas but recently in November 2006, the Meeting of Ministers of Education approved the Operational Plan for the creation of the System of Accreditation of University Careers of MERCOSUR (ARCU-SUR).

Currently, Bioengineering, Biomedical Engineering and Clinical Engineering Education Programs have been growing up significantly in Latin American Region. After 10 years of the accreditation process implementation in Latin America, there is a need for actualization. Interesting alternatives could arrive looking at the restructuring process of higher education adopted in Europe, starting with the so-called Bologna Declaration. Its objectives of increasing the comparability, compatibility, transparency and flexibility of higher education systems coincide with the concerns and interests already raised in various Latin American countries and with the proposals on quality assessment and accreditation exposed. On the other hand, the under graduate and graduate programs must be based on the global health needs of the region.

It is necessary to deepen the debate on our conceptions of quality in higher education beyond Latin America, and scientific societies can smooth the way to new and modern accreditation process. Improving the definition of the dimensions, criteria and indicators, working together, young countries and countries with experience, better methodological approaches to evaluation and accreditation could be proposed.

OR-150

Academic Programs in Mexico: The Current State of Biomedical Engineering 50 Years Later

Fabiola Martinez-Licona

Universidad Autonoma Metropolitana, Mexico

This presentation offers a comprehensive examination of the landscape of academic programs in Biomedical Engineering (BME) through the lens of a university with a rich history of providing such programs for over five decades. The Metropolitan Autonomous University (UAM) is one of the first institutions in Latin America to include an academic program in biomedical engineering. The evolution of the curriculum at the undergraduate level, the creation of the first postgraduate program in this discipline, the incorporation of professors trained in foreign universities in the most important BME research topics in the different decades, the influence in the region reflected in enrollment of students from countries such as Argentina, Colombia, Paraguay or Bolivia and the consolidation of the profession in Mexico through its graduate students, has given the university a unique personality and made it a Latin American benchmark. Delving into various aspects of BME education, the presentation sheds light on the journey of the educational institution, the evolution of curriculum development, and the dynamic realm of BME research. It navigates through the milestones achieved and hurdles in shaping BME education in Mexico. Key discussion areas include the inception and expansion of BME programs, innovative curriculum design, impactful research endeavors, and fruitful collaborations with industry partners and healthcare organizations. By reflecting on past endeavors and analyzing current trends, the presentation provides valuable insights into the accomplishments and challenges encountered in BME education in Mexico. Furthermore, it seeks to identify promising avenues for future growth and advancement in the field, thereby fostering a vibrant ecosystem for BME education and research in the country.

OR-151

Integration of health technology management in healthcare service delivery systems in Kenya

Salome Mwaura

Association of medical engineering of Kenya, Kenya

Medical are devices developed to solve a health problem and improve quality of life. Health care providers require Medical Devices for effective and efficient preventive, diagnosis, treatment and rehabilitation services.

Due to the importance of Medical Devices the WHO expanded its scope and replaced the term with Healthcare technologies.

WHO has a mandate, as outlined in the World Health Assembly (WHA) Resolution 60.29 "to encourage member states to draw up national or regional guidelines for good manufacturing and regulatory practices, to establish surveillance systems and other measures to ensure the quality, safety and efficacy of medical devices and, where appropriate, to participate in international harmonization"

Target of Health Technology

• Improve quality of Health delivery service
• Improve efficiency
• Improve effectiveness
• Reduce costs
• Improve accessibly of health services

Health Technology Planning

• If you fail to plan you are planning to fail
• For proper Management of HT there must be a work plan
• Work plan must consist of at least the following

Random sampling of few public hospitals raised the following issues of concern;

• Biomeds are still not fully integrated into our health systems
• Budgetary allocation for maintenance and investment in medical equipment/health technology is very low and not based on any data (irrational)
• Technical competence of Biomeds to repair/provide maintenance service is questionable (level of training)

Conclusion

• Health technology will bring a revolutionary change in the health sector. Therefore Embracing Health technology for Health workers is inevitable.
• Patients are also increasingly becoming aware of their health rights and this is a threat to doctors. (Information available in the internet, information centers, etc)
• There is need for Biomeds to apt in the game of quality healthcare technology management.

OR-152

Managed equipment service in Kenya

Symon Mbakah
Association of Medical Engineering of Kenya, Kenya

The Managed Equipment Service in Kenya is an Idea that was initiated in the year 2015 with the aim of improving healthcare service delivery in Kenya and to enable in realization of Universal health Coverage as well as Kenya's vision 2030. The idea involved leasing of medical equipment to address key areas in specialized healthcare targeting Non-Communicable Diseases (NCDs), such as cancer, renal, diagnostic, radiological and critical care services. chronic diseases like cancer and diabetes. Kenya, along with other United Nations member states, is working towards achieving Universal Health Coverage (UHC) by the year 2030. The World Health Organization defines UHC as the 'ability for people to receive health services without suffering financial hardship. The Kenya Vision 2030 aims to transform Kenya into a middle-income country that provides better quality life to all its citizens. Good health promotes economic growth by boosting productivity and contributing to poverty reduction. Managed Equipment Service arrangement ensures that public hospitals have access to modern health infrastructure, equipment and/or services over an agreed period , with the government making regular, pre-arranged payments based on agreed performance parameters.

The Areas of focus included: Theatre Equipment , Sterilization Equipment and Theatre Instruments, Renal Dialysis Equipment ,Intensive Care Unit (ICU) Equipment and X-ray and other Imaging Equipment.

The Implementation of this project has however done great to the Kenya's population and many can attest to this fact. The Project has seen hospitals benefit from specialized, modern and state-of-the-art medical equipment and by extension, upgrading of hospitals to accommodate these equipment, training of hospital staff both Technical and users some in factory training and other on site training continuously. Citizens having access to uninterrupted, quality, specialized Healthcare services regardless of location within Kenya, Regular service, maintenance, repairs and replacement of spare parts for all equipment throughout the programme at no additional cost to the counties, Improved services in the hospitals due to reduced equipment faults and malfunctions, Reduced referrals and importantly Reduced Mortality rates greatly.

Although the Projects had its own challenges we cannot forget to underscore that the gains achieved from this iniative are ernoumous and thus important for developing nations, low resource countries can try this approach of medical equipment manaagement.

OR-153

Needs assessment in Kenyan healthcare facilities for context-sensitive design of medical devices

Florinda Coro[1], Bazil Mlamba[2], Augustine Waswa[2], Carmelo De Maria[1], June Madete[2], Valentina Mangano[1], Margaret Keraka[2], Arti Ahluwalia[1]

[1]University of Pisa, Italy

[2]Kenyatta University, Kenya

Medical devices (MDs) are essential to deliver healthcare services effectively, but most of the world's population cannot access safe and appropriate MDs. According to the World Health Organization, in low-resource settings (LRS), 80% of the medical equipment is donated and, less than one-third of it becomes operational.

Providing equitable access to MD technology is a challenge; it requires comprehensive knowledge of local constraints and needs. Our objective was to conduct a needs assessment on-field study to maximise the effectiveness of medical equipment and design context compatible MDs in LRS.

The study, approved by the Kenyatta University Ethical Review Committee, was carried out from June to August 2023 in Nairobi in collaboration between the University of Pisa and Kenyatta University. Six healthcare facilities representing different levels (primary, secondary, and tertiary) and sectors (private, public) were included in the study, to capture generalizable constraints of LRS and to obtain a checklist of characteristics that biomedical engineers must consider when designing MDs to be used in these environments. The first qualitative phase was carried out through a focus group (N=4) and semi-structured interviews (N=3) with biomedical engineers. Then, a questionnaire on different aspects of MD management (to be rated from 1 to 5) was delivered to healthcare workers employed in the facilities selected for the study (N=54).

The results of focus groups and semi-structured interviews were used to refine the questions to be included in the questionnaires for quantitative research. Answers were more heterogenous in the public than in the private sector. For example, the availability of electrical security systems in private facilities was rated consistently (75% of participants 5/5, 25% 4/5), whereas in one public facility, the opinions of the respondents were at odds with each other: 85% rated the systems as 5/5, while 15% rated them as 2/5. In public facilities, which are much larger and have a bigger user pool, the most critical units are better maintained than others. Critical issues were found in the procurement of both spare parts (52%) and consumables (43%). Furthermore, maintenance was carried out by internal staff who are not adequately trained in 50% of cases. The human resources employed were rated insufficient by 35% of the participants.

Overall, our results show widely different problems, perceptions, and constraints (economic, human resources) across structures even in the same region, indicating that a more systematic methodology for context-sensitive development and deployment of MDs is needed. Our current studies are geared in this direction.

OR-154

Standardisation of Medical Devices: A Contended Practice with Potential Benefits for South African Healthcare

Sudesh Sivarasu

University of Cape Town, South Africa

Stakeholder dialogues within the Western Cape's medical equipment maintenance sector have sparked a debate regarding standardising medical devices in South Africa. Advocates from both public and private health sectors suggest that unifying medical equipment practices can enhance patient safety and lead to cost savings. However, this stance faces opposition, notably in the public finance domain and in some approaches from the global north, which perceive standardisation as a potential hindrance to competition and innovation.

Our investigation critically assesses the arguments for and against standardisation, considering its potential as a recommended practice in South Africa and comparable economies. The literature on the subject remains limited, with some critiques citing concerns that cost-driven standardisation could compromise patient safety by neglecting specific device requirements. Moreover, international advocacy for standardisation is lacking as a strategic approach to achieving Universal Health Coverage or the Sustainable Development Goals.

In South Africa, policies such as the Public Finance Management Act clearly oppose standardisation, framing it as anti-competitive. Despite these challenges, certain hospitals and clinical departments, especially within

the private sector, proactively implement standardisation for its reported safety, training efficiency, and maintenance benefits.
This research illuminates anecdotal evidence suggesting that standardisation can reduce costs and enhance patient safety through uniformity of equipment, ease of maintenance training, and availability of spare parts in settings where healthcare resources are constrained and the care burden is heavy, advocating for standardisation deserves further scrutiny. Such exploration should be balanced with thorough health technology assessments, allowing for a nuanced approach that prioritizes patient welfare over competitive market principles.
References: Hyman, W.A. "Device standardisation can be dangerous." Infection Control Today, 2018. Available at: https://www.infectioncontroltoday.com/view/device-standardization-can-be-dangerous [accessed on May 24, 2023]. Public Finance Management Act, Act No. 1 of 1999. Available at: https://www.treasury.gov.za/legislation/pfma/act.pdf [accessed on May 26, 2023].

OR-155

Digitizing Malaria Case Management Protocol in Ghana: A pilot Study

George Boadu
Komfo Anokye Teaching Hospital, National Centre for Radiotherapy and Nuclear Medicine, Ghana

Introduction and Background: It has been a common practice in Ghana for patients to seek first aid medical attention from community pharmacies or chemical shops. Management of malaria cases is no exception to this, as many patients who experience symptoms of malaria visit pharmacy shops to seek medical attention. The Ghana Health Service guidelines for malaria case management ensure that all persons presented with malaria symptoms at any health facility including pharmacy and chemical shops are tested through microscopy or malaria Rapid Diagnostic Test (mRDT). Malaria case management interventions such as point of care testing using mRDT kits ensures accurate diagnosis and effective treatment and can be well monitored through a real time data capturing solution. This study evaluated the use of a mobile health technology platform, known as the Fionet Platform to remotely monitor malaria RDT testing and understand issues faced by healthcare workers in using the malaria diagnosis test kits.
Methods: To ensure adherence to malaria case management protocol of 'Test, Treat and Track (T3s), a mobile phone installed with the Fionet App was deployed. Under this pilot study, 28 pharmacy shops were selected from Greater Accra Region and 13 Over the Counter Medicine Shops (OTCMS) from Central Region were selected. The pharmacists and Medical Counter Assistants from these facilities were trained to use the Fionet mobile phone App for malaria testing. The shops were also supplied with RDTs through the National Malaria Control Programme. Inventory of RDTs supplied to these shops were tracked to ascertain whether some tests were conducted without using the Fionet App and to understand the motivations behind the bypass through interviews.
Results: A total of 5312 RDT tests were recorded through the Fionet platform, out of which 3972, representing 74.7% were malaria antigen negative and 1286 (24.2%) were malaria antigen positive. The uploaded records also reported 1.05% tests as error. 91.91% of malaria positive cases were treated with ACTs, where as 14.85% of malaria negative cases were also treated with ACTs. Of the malaria negative cases that were treated, 9.1% of patients insisted they want ACT treatment and 91.8% were given ACT treatment because the patients were showing malaria symptoms according to the caregivers. For the RDTs that were not processed through the Fionet platform, the caregivers indicated that the incubation period is too long when they use the Fionet platform, as it compels them to stick to the incubation period.
Conclusion/Recommendation: The gold standard for malaria treatment should be followed to ensure continuous drug.

OR-156

From Emergency to Enhancement: Streamlining Ventilator Procurement in Africa for Improved Healthcare Outcome

Sudesh Sivarasu
University of Cape Town, South Africa

In the wake of the COVID-19 pandemic, the management of health technology in Africa has come under scrutiny, highlighting a reliance on the "if it works, let it work" philosophy. This perspective, though it emphasises operational stability, neglects the progress-

ive nature of healthcare necessities, particularly evident in the procurement of ventilators. Traditional bureaucratic barriers, exemplified by South Africa's stringent B-BBEE rating system, exacerbate the lag in accessing these life-saving devices, directly impacting healthcare quality and responsiveness.
The abstract delves into the ventilator case study, exploring the advancements and challenges associated with their procurement in African health systems. It proposes the harmonisation of medical device regulations as a pivotal solution for expediting the introduction of locally manufactured health technologies into the market. With a specific focus on ventilators, our research suggests that streamlining approval processes could be revolutionary, fostering the medical device industry's growth and sustainability within the continent.
Through this abstract, we aim to spark constructive discourse on eliminating procurement roadblocks. By adopting a unified regulatory framework, innovation can flourish, and health technologies, like ventilators, can become more accessible. Such advancements are crucial for creating a resilient and equitable healthcare infrastructure, ensuring all African nations are better equipped to improve health outcomes and strive toward universal health care coverage.

Artificial intelligence in healthcare

Wednesday late afternoon Track C
Jun 12, 16:00 - 18:15

OR-157

Insights in Data Generation: A Synthetic Data Approach for Enabling Small Datasets in Atrial Fibrillation Research

Ali Salman[1], Francesco Goretti[2], Alessandra Cartocci[1], Ernesto Iadanza[1]
[1]University of Siena, Italy
[2]University of Florence, Italy

This study explores the Gaussian Copula Synthesizer's (GCS) utility in addressing the limitations of a small dataset (58 real patient records) in Atrial Fibrillation (AF) research, focusing on Heart Rate Variability (HRV). Leveraging this method, we generated a realistic synthetic dataset of 1, 000 records, replicating the features observed in the original records. The GCS effectively expands dataset size while maintaining HRV pattern realism. This aids in developing and refining models used in AF research, overcoming challenges associated with limited sample sizes. Emphasizing privacy considerations, this approach showcases the potential of classic statistical methods in synthetic data generation for advancing AF research within the constraints of small datasets.

OR-158

An explainable deep-learning model to aid in the diagnosis of age related macular degeneration

María Herrero-Tudela[1], *Roberto Romero-Oraá*[1], Roberto Hornero[2], Gonzalo C. Gutiérrez-Tobal[1], María I. López[1], María García[1]
[1]University of Valladolid, Spain
[2]Universidad de Valladolid and Centro de Investigación Biomédica en Red en Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN), Spain

Age-related macular degeneration (AMD) is the most frequent cause of blindness in people of an advanced age. As AMD is asymptomatic in its early stages, this condition is normally identified in advanced stages of the disease, when treatments are less effective. To address this challenge, automated AMD image assessment systems offer the potential to significantly reduce the time, costs, and effort involved in screening. While previous works have demonstrated success for AMD detection using convolutional neural networks, their lack of explainability mechanisms limits their use in clinical settings. To address this limitation, we propose an explainable deep-learning approach using Local Interpretable Model-agnostic Explanations (LIME). Our model, based on RegNetY-320, achieved 86.5?curacy, 85.21% sensitivity, and 91.01% specificity on the Automatic Detection challenge on Age-related Macular degeneration dataset. Through the LIME technique, we identified the specific areas in retinal images that influence the prediction of the model, providing a tool for clinical interpretation and enhancing diagnostic confidence.

OR-159

Wearable sensors and artificial intelligence for blood pressure estimation during daily life and sleep, a pilot study

Katy Stokes[1], Salman Haleem[2], Rossana Castaldo[3], Francesco Cappuccio[1], Leandro Pecchia[1]
[1]University of Warwick, United Kingdom

[2]Queen Mary University of London, United Kingdom
[3]IRCCS SDN-SYNLAB, Italy

High blood pressure is the leading risk factor for development of cardiovascular disease (CVD). It is now understood that 24-hour and nocturnal measures are better predictors of CVD than one-off measurements. Despite this, devices are costly, uncomfortable, inaccurate and disrupt sleep. Machine learning has been applied to the electrocardiograph (ECG) for blood pressure estimation with a view to development of non-disruptive continuous blood pressure monitors. Prior studies have focused on data collected under highly controlled settings in hospitalised populations, this study assesses machine learning's viability with wearable ECG sensors in real-life scenarios.
In this study, a protocol was developed, and data were prospectively collected from 30 volunteers for a 24-hour free-living period of continuous ECG, ambulatory blood pressure monitoring and continuous glucose measurements. Machine learning models, emphasising understandable ECG features and interpretable models, were trained and tested through a thorough holdout process. Different combinations of ECG morphology features and activity metrics were used as inputs. The final model achieved a mean absolute error of 7mmHg and Pearson's' correlation coefficient of 0.48. Statistical and feature importance analysis identified key ECG regions for blood pressure prediction.
This research improves the understanding of the feasibility of continuous blood pressure monitoring during daily activities and sleep using machine learning and wearable ECG signals. Inherent data quality challenges associated with wearable sensors must be addressed in consideration of the aspects of interest of the ECG signal.

OR-160

Unlocking robotic potential through modern organ segmentation

Ansh Chaudhary, Robail Yasrab
CCIR, United Kingdom

Deep learning has revolutionized the approach to complex data-driven problems, specifically in medical imaging, where its techniques have significantly raised efficiency in organ segmentation. The urgent need to enhance the depth and precision of organ-based classification is an essential step towards automation of medical operation and diagnostics. The research aims to investigate the effect and potential advantages transformer models have on binary semantic segmentation, the method utilized for the project. Hence, I employed the SegFormer model, for its lightweight architecture, as the primary deep learning model, alongside the Unet. A custom 2D computerized tomography (CT) scan dataset was assembled, CT-Org2D through meticulous operations. Extensive experiments showed that, in contrast to the selected models, the task's simplicity required a redesigned Unet architecture with reduced complexity. This model yielded impressive results: Precision, Recall, and IOU scores of 0.91, 0.92, and 0.85 respectively. The research serves as a starting point, motivating further exploration, through different methodologies, to achieve even greater efficiency in organ segmentation.

OR-161

Rare Eye Diseases Automatic Classification: A Deep Learning Approach

Jacopo Vitale[1], Maria Elisabetta Pagnano[1], Margherita Anna Grazia Matarrese[1], Rosa Boccia[2], Paolo Melillo[2], Francesco Testa[2], Francesca Simonelli[2], Leandro Pecchia[1]
[1]Università Campus Bio-Medico di Roma, Italy
[2]University of Campania "Luigi Vanvitelli", Italy

Two uncommon genetic eye disorders, Retinitis Pigmentosa (RP) and Stargardt Disease (STGD), both classified as Inherited Retinal Diseases (IRDs), are subjects of investigation for potential treatments employing advanced technologies, including artificial intelligence (AI) with fundoscopy. These IRDs underscore the complexities of genetic eye disorders, emphasizing the imperative for sustained research efforts and innovative interventions, including AI applications, to mitigate the impact of vision loss. The aim of this work is to create an algorithm for automatically classifying the fundoscopies of 74 paediatric eyes. Three artificial intelligence algorithms are developed, a Custom Residual Net, a Custom Vision Transformer and a YOLO Net. Among the three mentioned algorithms, only the YOLO Net successfully classifies the test set samples without committing any misclassification errors. The ultimate goal of this study is to introduce the most effective classification algorithm to aid in the diagnostic process of rare diseases.

OR-162

Empowering Colorectal Cancer Research through Advanced Data Integration and Analysis: A case study of the DIOPTRA project

Marilena Tarousi, Stavros-Theofanis Miloulis, Maria Haritou, Konstantinos Bromis, Ioannis Kouris, George Botis, Ioannis Kakkos, George Matsopoulos
Biomedical Engineering Laboratory, School of Electrical and Computer Engineering, National Technical University of Athens, Greece

The escalating incidence of colorectal cancer (CRC), paired with the progressively decreasing age threshold and the low screening adherence by citizens, underscores the urgent need for innovative approaches to screening and early detection. In this light, the DIOPTRA EU project presents a pioneering initiative aimed at harnessing advanced data collection, integration, and analytics methodologies to unlock critical insights into CRC. This paper provides a comprehensive overview of the DIOPTRA platform's conceptual architecture and its potential implications for addressing CRC research challenges. Leveraging data integration, artificial intelligence, and state-of-the-art biomarker analysis, DIOPTRA offers a promising solution for enhancing early detection and thus improving patient outcomes. The integration of the DIOPTRA Back-end, facilitating data ingestion, curation, and storage, with the Front-end's user-friendly interfaces and a dedicated anonymization tool, offers the required link between clinical practice and innovative research in CRC screening programs. By fostering interdisciplinary partnerships and embracing continuous innovation, DIOPTRA has the potential to revolutionize CRC screening practices, reduce mortality rates, and shape the future of healthcare delivery. In this regard, this paper stresses the importance of ongoing efforts to advance cancer screening technologies, highlighting the role of integrated platforms like DIOPTRA in improving public health outcomes through multidisciplinary research within clinical settings.

OR-163

Predicting Depression Status After Transcranial Direct Current Stimulation Treatment Using Machine Learning

Sayna Rotbei, Giordano D'Urso, Alessio Botta
University of Naples Federico II, Italy

Depression is a serious medical illness that adversely affects how a person feels, thinks, and behaves. This illness can be treated with the aid of Transcranial Direct Current Stimulation (tDCS), which can help to reduce the symptoms of depression. The level of illness is typically evaluated using the Hamilton Depression Rating Scale (HDRS). The focus of this paper is the prediction of the HDRS score after a tDCS course. By predicting the result of tDCS, psychiatrists can provide better counseling to the patients about their future conditions after the treatment and decide wisely about the treatment method. We used different kinds of demographic information, treatment information, and the HDRS score before the treatment as predictors and supervised Machine Learning (ML) algorithms for the prediction. The analysis is conducted on 169 patients with depression. Our preliminary results show that the accuracy can be up to 63% when predicting the value of HDRS after tDCS treatment sessions as a binary variable using Gradient Boosting.

This is encouraging on such a small data set. Moreover, our results provide insight into the predictors pivotal to this outcome. They show that the HDRS score at baseline, the age, and the gender of the subject are the three main predictors. The results suggest this methodology may yield very interesting results.

OR-164

Evaluation of Hydrogel Flow into Osteoporotic Trabecular Bone: A Computational Fluid Dynamics Study

Fahad Alabdah[1], Adel Alshammari[1], Araida Hidalgo-Bastida[2], Glen Cooper[1]
[1]School of Engineering, University of Manchester, United Kingdom
[2]Department of Life Sciences, Manchester Metropolitan University, United Kingdom

There is significant potential in the treatment of osteoporosis using hydrogels tissue scaffolds impregnated with cells, growth factors and antibiotics. However, the delivery of hydrogel into the bone is yet to be developed. Non-invasive delivery is desirable for both patients and healthcare systems. Aim: evaluate hydrogel flow mechanisms and how that can affect the bone structure as well as the impregnated cells to begin the understanding of injection delivery. Methods: hydrogel flow dynamics are investigated using a linear laminar flow computational fluid dynamics model. Three cases with different Reynold's (Re) numbers were simulated and trabecular bone wall shear stress, and hydro-

gel flow velocity were extracted to evaluate bone/cell damage and velocity profile. Results: higher Re number which is proportional to higher inlet velocity is associated with higher bone wall shear stress, and hydrogel pressure. Although the shear stress and pressure do not pose any risk regarding the bone structure, the cell viability is compromised in the case of Re=6. Conclusions: the out-come of this study provides insights that will contribute to the design of a hydrogel injection procedure. Further work is needed to improve the model to further inform hydrogel delivery mechanisms.

OR-165

Enabling COVID-19 detection from multiple audio recordings: a preliminary comparison between cough, breath, and speech signals

Alfonso Maria Ponsiglione[1], ***Francesca Angelone***[1], Rossella Sparaco[1], Salvatore Piccolo[1], Amy Parrish[2], Andrea Calcagno[3], Guillaume Fournier[2], Ayana de Brito Martins[4], Fulvio Cordella[4], Arianna Arienzo[4], Lorenzo Castella[3], Vincenzo Norman Vitale[1], Francesco Amato[1], Maria Romano[1]

[1]University of Naples Federico II, Italy

[2]Laboratoire National de Santé, Luxembourg

[3]University of Turin at ASL "Città di Torino", Italy

[4]VoiceMed S.a.r.l., Luxembourg

Patients with COVID-19 experience severe respiratory and vocal difficulties as well as symptoms that give rise to unique audio characteristics in their voices. The present study takes advantage of vocal biomarkers extracted from cough, speech and breathing audio recordings obtained through personal smartphones from both SARS-CoV-2 virus-infected persons and non-infected participants accessing two different healthcare facilities. The results provide findings on the use of acoustic feature sets taken from low-level feature representations for COVID-19 recognition from cough, breath, and speech patterns. Machine learning models were trained on datasets from individual vocal exercises and on a dataset from combined exercises (cough, breath, and speech). The classification models provided up to 68.6?curacy, 86.7% sensitivity, and 66% specificity, whose values and most significant features vary according to the type of vocal pattern examined and the type of model adopted, indicating that audio characteristics may be used to detect COVID-19 symptoms and that the combined use of multiple audio patterns from different vocal tasks can achieve the most encouraging results in terms of classification performance.

S11 – IFMBE Education in BME: Education in Biomedical Engineering for Students

Thursday morning Track B
Jun 13, 10:30 - 12:00

OR-166

An introduction to Ventra; a programmable abdominal phantom for training, educational, research, and development purposes

Salar Tayebi[1], Ashkan Zarghami[1], Manu Malbrain[2], Johan Stiens[1]

[1]Vrije Universiteit Brussel, Belgium

[2]Medical University of Lublin, Poland

In recent years, several concepts of medical equipment have been recommended to measure intra-abdominal pressure (IAP). According to the research guidelines of the Abdominal Compartment Society (WSACS), every novel method to measure IAP should be strictly validated against the actual gold standard of the IAP measurement technique, which is an indirect measurement method through the bladder. Therefore, further validation studies should be conducted to systematically investigate different criteria and the robustness of a novel alternative for IAP monitoring. Clinical studies provide the highest level of evidence and insight, but they are often expensive and not always feasible for investigating novel concepts. Preclinical experiments involving cadaveric or animal specimens encounter various challenges. Human cadaveric tissue availability is limited, and ethical concerns surround animal experiments. In previous years, abdominal phantoms have been used for different purposes including medical imaging research and development, radiotherapy dosimetry studies, hernia repair, laparoscopic and robotic surgery training, and abdomen biomechanical studies. Nevertheless, no abdominal phantom has been developed to simulate the IAP in an artificial abdominal compartment. This study aims to introduce the "Ventra" as an abdominal phantom that is able to simulate intra-abdominal pressure, abdominal compliance, respiration-related pressure variations, and urine input and output, and is compatible with intra-vesical and intra-gastric measurement devices for validation, educational,

and training purposes. The abdominal compartment is designed as an inflatable balloon with a total volume of 4000 mL. An artificial bladder was made using 500 mL styrene ethylene butylene balloon (and placed inside the abdominal compartment. Subsequently, Foley catheters and nasogastric tubes were connected to make the phantom compatible with intra-gastric and intra-bladder pressure measurement devices. Vacuum DC pumps were used to inflate and deflate the abdominal compartment and to increase and decrease the IAP. Two peristaltic pumps were also used to instill and remove fluid to and from the bladder. As the next step, a graphical user interface was made to enable the user to control the phantom. Several validation analyses were done to ensure the functionality and performance of the phantom. Reviewing the validation results, we can see that Ventra shows excellent reliability and accuracy in simulating different IAP, compliance, and respiration variations, and marks a significant step forward in the realm of medical training, education, and research.

OR-167

Ethics as part of biomedical engineering and informatics education

Lenka Lhotska
Czech Technical University in Prague, Czech Republic

Ethics education in engineering has undergone significant evolution since its inception in the 1970s, yet its integration into curricula remains inconsistent across disciplines. As a research discipline, engineering ethics education appeared in late 1990s and early 2000s. While biomedical engineering (BME) programs at institutions such as the Czech Technical University in Prague began incorporating ethics education in the 1990s, other fields like electrical engineering and information technology have been slower to adopt similar initiatives. Although ethics is present to a certain degree in BME and biomedical informatics education, it has not yet fully reflected the issues connected with artificial intelligence (AI) applications in biomedicine. As AI becomes more prevalent, it introduces complex ethical concerns related to privacy, security, fairness, and social discrimination. Addressing these challenges requires a workforce that can understand and navigate the ethical implications of AI development and implementation. AI's integration into medical diagnostics offers a pertinent example. Machine learning algorithms, fueled by vast datasets, have shown promise in areas like disease detection and treatment planning. However, concerns about bias, data privacy, and algorithmic transparency underscore the critical need for ethical considerations within AI-driven biomedical applications. For instance, the reliance on biased datasets in AI diagnostics could perpetuate disparities in healthcare outcomes if not addressed ethically. We see that ethics should be seamlessly integrated into engineering courses to emphasize its relevance in real-world applications. By providing students with ethical frameworks and tools to navigate complex ethical dilemmas inherent in AI-driven biomedicine, engineering education can cultivate a generation of responsible technologists. Recently we started an Erasmus+ project whose goal is to integrate teaching of ethical considerations related to AI into engineering faculties at higher education institutions, utilizing innovative pedagogical approaches. The project will produce three concrete results. The first is Ethical AI Case Studies & Starter Kit, which includes case studies and starter kits to teach engineering students about the ethical implications of their work. The second is Ethical Engineer OERs, flexible open education resources based on real-world case studies that lecturers can use to teach AI & Robotics Ethics in their programs. Finally, the project will create Ethical Engineer Bootcamps, an interdisciplinary approach to teaching ethical considerations in AI and robotics to students that will be systematised in a guide for other institutions to replicate.
The work is supported by the project No. 2023-1-CZ01-KA220-HED-000160663 Ethical Engineer: Integrating teaching ethics in artificial intelligence and robotics into Engineering Education of Erasmus+ programme.

OR-168

Implementation of a Pattern Classifier on Thermograms from Plantar Region

Santiago Humberto Ramirez Martinez, Martha L. Zequera, Francisco Carlos Calderón Bocanegra
Pontificia Universidad Javeriana, Electronics Department - Footlab, Colombia

This study aims to implement a pattern classification algorithm for plantar thermograms, focusing on identifying altered temperature zones in the feet of diabetic patients. Utilizing a database of 334 thermo-

grams, various classi-fication algorithms including Support Vector Machine (SVM), Logistic Re-gression, Artificial Neural Network (ANN), Random Forest, and K Nearest Neighbors (KNN) were evaluated. Features extracted from the literature, such as number of pixels, maximum entropy, variance, mean value, correla-tion, contrast, energy, and homogeneity, were utilized for training and evaluation. The classification task involved assigning thermograms to 5 classes based on the thermal change index (TCI).
Performance evaluation was conducted using an information theory metric approach based on mutual information, measuring the alignment between predicted and true classes. The neural network achieved the highest mutual information score of 2.69 out of 5, indicating that approximately 53.8% of the information obtained from model predictions aligned with the true classes. Additionally, a database was established in the Footlab BASPI laboratory, comprising 20 thermograms from the plantar region of 10 control subjects. A novel protocol, incorporating additional elements to the STANDUP base protocol, was proposed.
Finally, classification using the ANN on data acquired from the Footlab - BASPI database yielded satisfactory results, successfully distinguishing between 1.7 classes, representing an 85% success rate in classifying thermograms.

OR-169

Using 24-hour Heart Rate Variability indices for prognosis monitoring in heart failure patients

Shi-Yi Wu, Shao-Hung Lu, Mei-Fen Chen, Wen-Chen Lin, Wen-Chi Lin, Cheng-Lun Tsai, Kang-Ping Lin
Chung Yuan Christian University, Taiwan

Heart failure (HF) patients experience impaired contraction or relaxation of the heart, leading to inadequate blood circulation, which can easily result in complications such as pulmonary edema or difficulty breathing. Due to the influence of sleeping posture at night, pulmonary edema is prone to worsen. Normally, heart rate variability (HRV) should exhibit a diurnal rhythm, but after the onset of heart failure, the body's sympathetic nervous system regulation capability decreases, potentially causing disruption in the diurnal rhythm of the heart. Based on this theory, this study collected 24-hour electrocardiogram (ECG) data from three groups of subjects: normal, hypertension, and heart failure. Diurnal HRV parameter trends were analyzed to identify potential indicators for monitoring the prognosis of heart failure patients. Using commercially available Holter monitors, one set of 24-hour ECG data was collected for each group: normal, hypertension, and heart failure. Every half hour, a 5-minute segment of ECG was selected for short-term HRV analysis. Analyzed parameters included SDNN, LFP, and HFP. Results showed significant diurnal differences in SDNN, LFP, and HFP indicators among normal subjects, whereas diurnal differences in HF subjects were not significant. This might be due to the disappearance of diurnal rhythm in sympathetic and vagal nerves of HF patients or a decrease in regulatory capacity. Hypertension subjects exhibited diurnal differences in indicators, but the differences were opposite to those of the normal control group, indicating that the heart still has regulatory capacity but is under load during rest. Through analysis of diurnal HRV, this study demonstrated distinct patterns of HRV in HF subjects compared to the other two groups, serving as one of the reference indicators for the prognosis of HF patients.

OR-170

Proposal for the Application of Blockchain in Predictive Management in Medical Devices

Mariana Brandão, Renato Garcia
Institute of Biomedical Engineering (IEB-UFSC), Brazil

The veracity and reliability of information in the health sector is essential for security in the Predictive Health Technology Management (HTM) and quality in patient care in health care establishments. One technology that has been contributing to the traceability and security of data is Blockchain, which consists of a decentralized network for storing transactions in an immutable way. The objective of this work was to develop a study of the intersection between blockchain technology and the application of HTM by Clinical Engineering. A rapid literature review of blockchain applications in medical devices was developed and presented two models of integration of this technology in hospitals. The first proposal was about the incorporation of Blockchain in the traceability of information incorporated in the historical record in the lifecycle of the technology and the second in the application in calibration certificates and test reports on medical equipment.

OR-171

EMG Rehab: An interactive platform controlled by EMG signals to improve adherence to rehabilitation therapy in patients who have suffered lower body muscle injuries

Leslie Yessenia Cieza Huané, Ana Cristina Aldana Palomino, Sergio Enrique Moreno Elescano, Andre Jesus Cruces Chancahuaña, Angel Eduardo Dianderas Jorge, Pablo Cardenas Caceres
Facultad de Ciencias e Ingenieria, Universidad Peruana Cayetano Heredia, Peru

Physical rehabilitation is crucial to maximize function and minimize disability in those who have suffered patellar tendon , however it depends not only on the method, but also on how it is performed as depending on this the treatment may be more effective than another in the patient. This paper introduces EMG Rehab, an interactive platform for the physical rehabilitation of young college students who have suffered lower body injuries. Employing electromyography (EMG) in conjunction with the Bitalino device and Python programming language, quantifies muscle intensity during therapy. Through interactive gaming, EMG Rehab fosters more efficient and engaging treatment, characterized by a patient-centric approach that balances challenge and entertainment. The proposed platform utilizes EMG to assess muscle electrical activity, complemented by a dynamic rehabilitation environment featuring video games designed to motivate patients and facilitate targeted exercises. EMG Rehab offers personalized feedback by recording and analyzing muscle activity, empowering patients to track progress and improve performance. This interactive game-based platform is designed to engage young college students actively in therapy, thereby enhancing rehabilitation outcomes.

Clinical engineering

Thursday morning Track C
Jun 13, 10:30 - 12:00

OR-172

Assessing Perfusion Changes in Clinical Oncology Applications using Hyperspectral Imaging

Rok Hren[1], Jošt Stergar[2], Urban Simončič[2], Gregor Serša[3], Matija Milanič[2]
[1]Institute of Mathematics, Physics and Mechanics, Slovenia
[2]Faculty of Mathematics and Physics, University of Ljubljana, Slovenia
[3]Department of Experimental Oncology, Institute of Oncology Ljubljana, Department of Experimental Oncology, Slovenia

Hyperspectral imaging (HSI) holds potential in clinical applications, provid-ing valuable information about perfusion using visible light. The notable advantage of HSI is that it is non-contact, non-ionizing, and non-invasive, while also eliminating the need for contrast agents. In medical practices, HSI has shown promising results in detecting different types of carcinoma and assessing perfusion in healing processes like transplants and wound management. Considering the critical role of perfusion in oncology, we have reviewed the utility of HSI in quantifying perfusion changes during clinical interventions. Our review primarily focused on neoplasms located in anatomical sites such as the kidneys, breasts, eyes, brain, and gastrointestinal (GI) tract. Through our examination, we have established that HSI demonstrates remarkable potential as an imaging technique within a clinical oncology setting. Notably, we found the evaluation of mastectomy skin flaps perfusion after the breast reconstructive surgery and anastomotic perfusion during GI conduit reconstruction to be particularly promising.

OR-173

OHIO: Integrating IoT Technologies for Enhanced Clinical Engineering and Dynamic Tracking of Medical Equipment

Alessio Luschi[1], Gianpaolo Ghisalberti[2], Giovanni Luca Daino[2], Vincenzo Mezzatesta[2], Ernesto Iadanza[1]
[1]Department of Medical Biotechnologies, University of Siena, Italy
[2]Azienda Ospedaliero Universitaria Senese, Italy

The paper outlines the OHIO project, funded by the European Union's Horizon 2020 research and innovation action programme, via the ODIN – Open Call issued and executed under the ODIN project (GA 101017331), which focuses on the enhancement of hospital safety, productivity, and quality. The main objective of OHIO is to provide a solution to empower the management of hospital facilities in terms of clinical engineering and logistics for the use-case hospital "Le Scotte" in Siena, Italy. The OHIO framework integrates various technical solutions to address possible man-

agement challenges which may arise during the maintenance of medical equipment, such as the unavailability and the untraceability of a device, or the technicians' lack of knowledge on how to reach it. The paper also describes a set of Key Performance Indicators (KPIs) designed for measuring OHIO's impact on maintenance timings and efficiency. Preliminary outcomes show promising results in preventing failures, improving scheduling, and providing efficient indoor navigation. The OHIO project demonstrates potential enhancements in hospital operations and maintenance through digital IoT solutions, successfully responding to a set of previously unmet needs.

OR-174

An Innovative Solution for Efficient Workflow Management in Healthcare

Alessio Luschi, Ernesto Iadanza
Department of Medical Biotechnologies, University of Siena, Italy

Hospitals are challenged to provide a wider range of services due to a growing patient population, leading to a faster deterioration rate compared to other buildings. Recent years have seen a focus on improving maintenance management in hospitals through strategies, performance measurements, and Information Technology. Challenges include resource allocation, communication gaps, and workflow monitoring. Healthcare workflow management involves various stakeholders and aims to ensure safe, efficient, and effective patient care while minimizing waste and reducing costs. Workflow Management Systems (WFMSs) are promising solutions, automating administrative procedures to enhance efficiency and effectiveness in healthcare services. The paper presents a RESTful WFMS developed in Microsoft .NET 6, utilizing the open-source .NET library Elsa Workflows. It introduces pre-typed sub-workflows, each defined in JSON format, allowing users to customize workflows using Graphic User Interfaces (GUIs). The system stores information in a Microsoft SQL Server database and interacts with the hospital Computer Aided Facility Management (CAFM) system via APIs. The platform enables managers and department heads to create customizable workflows in a no-code environment. The system is used in an actual healthcare environment at the "Le Scotte" University Hospital in Siena, Italy.

OR-175

Towards the Creation of a National Medical Equipment Inventory

Aris Dermitzakis, Spilios Zisimopoulos, Nicolas Pallikarakis
Institute of Biomedical Technology (INBIT), Greece

During the last decades, medical technology has become a key factor in modern healthcare delivery systems. Despite that, as showcased in the WHO 2022 Global atlas of medical devices, most countries worldwide do not have any form of national medical equipment (ME) inventory, and in most cases where data is available, it refers to high capital value equipment. As a result, no immediate information about the operation, status and costs of ownership of the equipment is available to national healthcare authorities, health policy and decision makers and other stakeholders. Tending to the above issues, the Institute of Biomedical Technology (INBIT) has undertaken a nationwide project regarding the creation of an electronic ME inventory of all hospitals belonging to the public healthcare sector in Greece.

The procedure for creating the inventory enlists a room-by-room approach, where every piece of equipment is assigned a unique national device number, in the form of an indelible label bearing the number and a QR code. Essential data that will be included in the electronic record (ER) of each equipment contain photos, GMDN and UDI codes, manufacturer, model/type, year of manufacture, area of installation, operation status and acquisition method. Information like the technical support provider, acquisition costs and maintenance data can also be incorporated.

A comprehensive and updated ME inventory provides a clear picture of the technology available, is essential for strategic procurement planning and constitutes the cornerstone for the use of a Medical Equipment Management System (MEMS) and a Vigilance system. Another collateral benefit of a ME inventory can be the establishment of various ME related centralized databases. A ME group codification database, using the total GMDN groups will enable the seamless transition to a new system, like the EMDN. A model/manufacturer database will be fundamental, as it will allow checking at any time whether the devices installed in the country meet the necessary standards and specifications, as well as their involvement in adverse

events. Finally, a department database can help in the redesign and central organization of the health system, providing insight into the geographical distribution and operational status.
In conclusion, the availability of such reliable data regarding the installed ME is necessary for evidence-based decisions regarding investment planning, the rational management of the equipment and its safe operation. This will also form the basis for a centralized MEMS at a regional or national level.

OR-176

Implementing a Centralized Medical Equipment Management System on a National level

Aris Dermitzakis, Spilios Zisimopoulos, Nicolas Pallikarakis
Institute of Biomedical Technology (INBIT), Greece

The use of medical equipment (ME) is prominent and essential in every modern healthcare environment. ME management covers a wide range of important issues, including acquisition, evaluation, maintenance and adverse event reporting. Due to the complexity of modern technology, the use of medical equipment management systems (MEMS) is necessary, resulting in many and important benefits. An indicator of the above is the widespread usage of MEMS in European healthcare units during the last decades. However, according to data from the WHO 2022 Global atlas of medical devices, most countries lack a national inventory and MEMS. The Institute of Biomedical Technology (INBIT) has undertaken a pioneering project for the implementation of a centralized MEMS (web-Praxis) on a nationwide level in Greece. This system will allow for a complete and updated picture of the available equipment on the whole territory, its technical characteristics, geographic distribution, the operational status, the cost of ownership and other economic data among others.
Web-Praxis consist of various modules. The equipment electronic record module plays a pivotal role, as it encompasses information from other modules like Corrective and Preventive maintenance, Contract management, Geographical distribution, Vigilance, KPIs and Statistics. Relevant information includes identification data, photographic record, maintenance history, contracts and economic data. For the MEMS to be feasible, the existence of a ME inventory is a prerequisite and will also be established at a national level, as a part of the project.
This project aims to improve various aspects of the healthcare system. The computerized MEMS facilitates the tasks clinical engineers are responsible for performing and provides reliable data enabling evidence-based decision making. Strategic planning of investments will be feasible, knowing the installed ME and its operational status, as well as the overall capacity of healthcare units in different regions. A redistribution of ME can also be made, taking into consideration the real needs of health care units that may appear in special circumstances, like in the period of covid-19. In addition, equipment downtime is expected to be reduced. The various automated and streamlined processes encompassed by the MEMS not only limit the need for paper-based documentation, but also facilitate preventive maintenance schemes, thus reducing device malfunctions.
In conclusion, the implementation of a centralized MEMS is expected to improve the viability and robustness of the national healthcare system, through informed decision making, while at the same time enhancing accessibility to healthcare, patient safety and service quality.

OR-177

Calibration of medical equipment - why is it critical?

Symon Mbakah
Association of Medical Engineering of Kenya, Kenya

CALIBRATION OF MEDICAL EQUIPMENT - WHY IT IS CRITICAL?
Calibration of medical equipment is an activity carried to determine the conventional truth of the value of the designation of measuring tools and materials. This is done by comparing traceable measuring standards to national and international standards. It is actually a procedure for detecting and fixing the uncertainties in measurements and bringing them to an acceptable level. The accuracy of the device has a great deal of importance, as it can seriously affect the diagnostic procedure and endanger patients' life including the users as well. The deviation in output is not necessarily the fault of the device itself, nor can it represent the manufacturer's incompetence. Most commonly, it results from continuous device usage, which over time affects its internal components, resulting in a deviation from the device standard measurement

output. The reason why it is important calibration of medical equipment as a norm is simply to ensure that the results generated from the various medical equipment are accurate and therefore do not in any way harm the patient or the health worker. As a medical professional, you have a responsibility to your patients to make certain that your medical equipment is safe, accurate, and reliable at the point of use. Calibration is done to provide that the item is functioning properly and to ensure that the results or readings it provides are accurate. Individuals completing calibration need to be trained and are required to document the process to ensure any mistakes can be traced back to the source. When Clinicians are subjected to various results from this equipment as diagnosis, they proceed to prescribe drugs as well as administer procedures as dictated by the equipment results. However, some clinicians who have a wealth of experience occasionally may doubt the results and therefore will request a second opinion at the cost of the patients from other and in most cases the doubt is usually confirmed. To have medical equipment calibrated at some interval of time and the results circulated to the clinicians. There is therefore the need for trained Biomedical engineers, use of appropriate tools and adherence to calibration procedures at all times.

The paper will therefore give a highlight of the importance of calibration of Medical equipment, give incidences of misdiagnosis caused by lack of calibrations, guide on importance of allocating resources for calibration, training of continuous Biomedical engineers, monitoring and documentation of the entire process of calibration.

POSTER PRESENTATIONS' ABSTRACTS

Poster session

Tuesday morning poster session
Jun 11, 10:00 - 10:30

PO-01

Neural network based fetal ECG extraction from abdominal signals

Dragoș-Daniel Țarălungă[1], Radu Botezatu[2], Alina-Elena Sultana[1], Titus Mihai Vasile[2], ***Georgeta-Mihaela Neagu***[1]

[1]National University of Science and Technology Politehnica Bucharest, Romania

[2]Carol Davila University of Medicine and Pharmacy, Romania

Non-invasive foetal ECG extraction from abdominal signals might provide significant information for long-term foetal monitoring, being very attractive for physicist. Nevertheless, accurate extraction of the foetal ECG is a challenging task, due to the disturbing signals, which overlap the signal of interest in the frequency domain. Among the current denoising methods, neural net-works are very attractive due to their performance. The current paper pro-poses a linear feed-forward neural network that estimates very accurately the abdominal mECG, the strongest disturbing signal, based on two thoracic mECG, removing it thereafter. The obtained results are very promising, al-lowing the further investigation of the fHR, for the foetal well-being evaluation. The comparison with the event-synchronous interference canceller shows the advantage of the neural network in preserving the fECG morphology, with the cost of higher computation time. Both methods require the preprocessing of abdominal signal in order to remove the power line interference and the baseline wander.

PO-03

Fundamental study of Readiness Potential elicited by foot movement

Reon Takahashi, Puwadej Leelasiri, Tomoya Oi, Tatsuhiro Kimura, Hiroshi Ohshima, Kiyoyuki Yamazaki, Fumitaka Aki

Tokai University , Japan

In this study, we measured the Readiness Potential (RP) in the left and right foot under following three conditions, analyzed by ANOVA and multiple comparisons, and classified the conditions by LSTM, with the aim of elucidating the appropriate control of the Brain Machine Interface (BMI) and the decision logic of the AI. First, RP was measured in an electrostatic shielded room for each left and right foot under following three conditions. In the first and second conditions, participants imagined stepping on a button (Image) and stepped on a button (Move), and in the third condition, they stepped on a button at an arbitrary timing (Voluntary). The waveforms were then observed by an additive average of 50 trials. As the results using ANOVA, significant differences between the movement terms for the electrodes located in the frontal lobe were revealed, but not for the motion sides or the interaction effects. Multiple comparisons indicates that in the movement terms, the peak means were larger for Image, Move, and Voluntary, in that order, and the 95% confidence intervals were independent only for Voluntary. In the motion sides, the peak mean was larger for the left foot, but the confidence intervals overlapped each other. Furthermore, LSTM using the raw data was able to classify a total of six conditions, taking into account the movement terms and the motion sides, with a final value of 98.4% high accuracy and 0% loss. These results suggest that LSTM is promising for application to the RP based BMI by LSTM.As a consideration, the difference in RP peaks by movement terms may be due to the fact that the prefrontal cortex was activated more strongly in the image-directed than in the non-directed Voluntary. Furthermore, as for the motion sides, since the dominant foot of all participants was the right foot, the right foot was easier to move due to functional sharing on the motion sides. This may have resulted in a slightly smaller peak value for the right foot than for the left foot. In conclusion, ANOVA and multiple comparisons identified significant differences in prefrontal activation based on the presence of instructions for movement and functional sharing among motion sides. In addition, the highly accurate classification in LSTM shows promise for application of LSTM to BMI using EEG.

PO-05

Automatic detection of sympathovagal response using HRV analysis. Case study: resident surgeons during training and their first laparoscopic surgery

Maria Elisabetta Pagnano, Jacopo Vitale, Margherita Anna Grazia Matarrese, Gianluca Mascianà, Marco Caricato, Leandro Pecchia

Università Campus Bio-Medico di Roma, Italy

Monitoring the physiological response during training can provide valuable information about how surgeons cope with the stress associated with this activity. Heart Rate Variability (HRV) analysis is a widely used method of assessing the autonomic nervous system (ANS) response, providing important knowledge on the stress state of subjects and how the ANS intervenes in the response to such stress. During a stressful task, the ANS releases hormones such as cortisol and adrenaline into the bloodstream, triggering an increase in heart rate, increased perspiration, sharper concentration and other physiological processes. In this study, 6 resident surgeons were monitored at rest, during training with a surgical simulator, and during their first surgery. Correlations between HRV features and surgeon performance were investigated. Six Machine Learning (ML) models were trained to detect mental stress using a public dataset comprising 84 5-minute ECG recordings labelled as stress/rest. Subsequently, these models were tested on data collected from the resident surgeons. In conclusion, pre-trained ML models demonstrated significant efficacy, recognising mental stress in surgeons with a specificity and accuracy exceeding 80%.

PO-07

Preliminary development and evaluation of a low-cost digital stethoscope

Muyanga Kampekete[1], Francis Chikweto[2], Foster Munsanje[1], Boyd Mubanga[1], Conix Sunday[1], Jimmy Sikwese[1]

[1]Evelyn Hone College, Zambia

[2]Tohoku University, Institute of Development, Japan

Cardiovascular diseases (CVDs) are among the leading causes of deaths globally. The World Health Organisation (WHO) estimates that over 17 million lives from the patient population are lost due to cardiovascular diseases and this is a major concern. Cardiac auscultation using either acoustic stethoscopes or electronic versions still remains the most widely method for the assessment of cardiac functionality conditions and for the detection of holosystolic (mitral regurgitation and ventricular septal defect), systolic ejection (aortic stenosis or hypertrophic cardiomyopathy), and diastolic (aortic insufficiency and mitral stenosis) murmurs that can precipitate the presence of abnormal heart sounds indicating underlying pathological conditions. However, experience and domain expertise knowledge are required in order to accurately diagnose CVDs from cardiac sounds acquired by either acoustic or electronic stethoscopes. In many developing countries, like Zambia, with low doctor to patient ratios, there is a big shortage of experts which leads to limited access to quality healthcare.

This study proposes a preliminary development and evaluation of a low-cost digital stethoscope which leverages on machine learning to distinguish between normal and cardiovascular disease (CVD) related heart sounds. A prototype of a digital stethoscope is designed and developed with Bluetooth and universal serial bus (USB) technology. preliminary results show that the system records heart sounds with good quality and low noise. Machine Learning models such as K-Nearest neighbor (KNN), support vector machines (SVM) and artificial neural networks (ANNs) are trained and tested on features derived from the heart sounds or phonocardiogram signals (PCG) by Wavelet scattering and Fast-Fourier Transform (FFT). The overall validation accuracy range was 89.9%-98.5% and the models can effectively classify normal and abnormal heart sounds. These promising results will be of great importance for early detection of cardiovascular diseases, enabling timely intervention and disease management in low resource countries like Zambia.

PO-09

Trade-Off Between Real-Time and Classification Performance in Motor Imagery BCI

Aleksandar Miladinovic[1], Milos Ajcevic[2], *Katerina Iscra*[2], Francesco Bassi[2], Alessandra Raffini[2], Joanna Jarmolowska[2], Uros Marusic[3], Agostino Accardo[2]

[1]Institute for Maternal and Child Health "Burlo Garofolo" , Italy

[2]University of Trieste, Italy

[3]ZRS Koper, Slovenia

Brain-computer interfaces (BCIs) offer direct communication between the brain and external devices, holding immense potential across various applications. This study focuses on Motor Imagery-based BCIs (MI-BCI), decoding neural patterns associated with mentally rehearsed motor actions. Despite their promise, BCIs face challenges in real-world applications, primarily in reliability and complexity. While classification accuracy is a standard metric for BCI performance, the literature often overlooks real-time responsiveness. Many studies report classification out-

comes offline, disregarding the prompt translation of EEG signals into actions. The acceptable delay from EEG signal to action should not exceed 1 second; however, numerous studies employ time windows exceeding 4 seconds, affecting user control perception. This article aims to compare the trade-off between time-window length and classification accuracy in MI-BCI, using three linear classifiers (LDA, MLP, SVM). Participants include stroke patients and subjects from the BCI IVa dataset. Results demonstrate time-frequency plots indicating MI-related EEG changes, revealing a trade-off between accuracy and responsiveness. Our findings underscore the importance of addressing real-time responsiveness in BCI evaluations, proposing a balance for practical system utility. In conclusion, this study enhances our understanding of the delicate balance needed for optimal real-world application of MI-BCIs, emphasizing the trade-off between accuracy and responsiveness.

PO-11

Evaluation of Precursors to Momentary Sleepiness in Automobile Driving Using Cerebral Blood Flow Variability and Thermography

Tomoya Oi, Reon Takahashi, Puwadej Leelasiri, Kiyoyuki Yamazaki, Hiroshi Ohshima, Fumitaka Aki
Tokai University, Japan

In this study, we used a portable NIRS device and a thermal imaging camera to evaluate the stage of drowsiness in a simplified manner for the purpose of elucidating the antecedents of drowsy driving. Seven participants drove on a driving simulator while wearing an NIRS device on their foreheads and monitoring their skin temperatures with a thermal imaging camera, and a YouTube video was played to simulate driving on a highway. Dozing was defined as prolonged eye closure, and skin temperature of the nose was measured and filmed when judging dozing. Subjects were cautioned to concentrate on driving and not to try to force themselves to sleep. At the point when the subjects judged that they fell asleep, Hb concentration decreased from the starting point and returned to the original value when they awoke. Comparison by depth showed that the amount of change was greater at 3 cm. The amount of change in the right prefrontal cortex was also greater. Men's Hb concentrations fluctuated rapidly in relation to sleepiness, while women's increased slightly. There was little difference in mean temperature between resting and sleeping, and no decrease in nasal skin temperature was observed during sleep. We hypothesized that this is because a depth of 3 cm allows measurement to the cerebral cortex. We considered that the parasympathetic nervous system became active before sleep onset, which had a relaxing effect and increased blood flow. The right hemisphere is responsible for functions such as spatial attention and landscape perception, and it is assumed that these functions are related to driving. Males entered sleep in a short time and showed rapid fluctuations, while females took longer to fall asleep and showed gradual fluctuations. We consider it possible that men are accustomed to their environment and women are not accustomed to their environment. The nasal temperature did not decrease because of the shallow depth of sleep. We investigated changes in cerebral blood flow using the NIRS system and verified its relationship to sleep. It was found that measurement at deep depth was effective and that cerebral blood flow increased before sleep. To examine the possibility of detecting the antecedents of sleep, data before and after sleep should be taken in detail. Future work is to examine the relevance of the NIRS device by recording fluctuations in arousal levels by EEG and analyzing the correlations in detail.

PO-13

Use of ECG gating approach for high frequency ultrasound vector flow imaging

Chi-Hung Yang, ***Chih-Chung Huang***
National Cheng Kung University, Taiwan

High frequency ultrasound (HFUS, > 30 MHz) Doppler imaging has been used widely in many small animal and human applications due to its high-resolution ability. Vector Doppler imaging (VDI) also exhibits the advantage for visualization of complex flow patterns without considering the Doppler angle. However, there is no commercial HFUS VDI machine available to date, therefore, several studies have used the ultrasound research platform (Verasonics Vantage 256™) connect with a HFUS array transducer for HFUS VDI. Unfortunately, the maximum frame rate of Verasonics is only 10 kHz at 40 MHz operational frequency due to the limitation of hardware data transmission, which reduces the maximum detectable velocity of Doppler measurement due to the insufficiency of frame rate. To address this draw-

back, in the present study, an ECG-gating HFUS VDI was proposed to keep the maximum frame rate of 10 kHz in Verasonics for data acquisition to avoid the Doppler flow aliasing by aligning all the tilted angle plane waves to the ECG R-wave, which solves the trade-off between frame rate and multi-tilted angles in conventional VDI. The performance of the proposed data acquisition method for HFUS VDI was verified firstly through a steady flow phantom, which all the estimation errors are less than 10% under different flow settings. In animal studies, the peak velocities were measured through the ECG-gating HFUS VDI from mice carotid artery, left ventricle, and aortic arch, which were approximately 55 mm/s, 655 mm/s, and 765 mm/s. Compared to conventional method, no Doppler aliasing occurs in the proposed method because the frame rate is sufficient. All the experimental results demonstrated the proposed ECG-gating HFUS VDI has the potential to become a useful tool for vector flow visualization in small animals even under a high flow velocity.

PO-15

Intraoral scanner classification and accuracy evaluation using UV mapping of scan bodies

Mykolas Akulauskas[1], Darius Jegelevičius[1], Vygandas Rutkūnas[2], Liudas Auškalnis[3], Justinas Pletkus[2]

[1]Kaunas University of Technology, Lithuania

[2]Vilnius University, Lithuania

[3]DIGITORUM Research Center, Lithuania

Background: The crucial stage of dental implant placement with a digital workflow involves scanning the patient's dental arches using an intraoral scanner (IOS), where scan bodies (implant-positioning-transfer devices) are present. Despite IOS's advantages over traditional impressions, their accuracy evaluation is complicated by varied protocols and reliance on black-box solutions. The objective of this study is to develop algorithms that can distinguish between different IOS systems and to evaluate their accuracy using digitized scan bodies in a standardized format. Materials and Methods: The study's database includes 2222 scan bodies extracted from 698 dental arches, each digitized using four different IOS (PRIMESCAN, Carestream 3600, TRIOS3 and TRIOS4) and one laboratory scanner E4. For reference, the CAD model of the CARES RC Mono scan body was used. To standardize the scan bodies presented in polygon meshes, the UV mapping procedure was applied. First, contours (slices) of the scan body were obtained by rotating a vertical cross-section plane around the scan body's longitudinal axis by specific degrees, then identifying the closest point on the mesh for each rotated position. Second, for each vertex, three scalar values were calculated: the shape index, latitude angles, and the area of the Voronoi cell. Contours, which contain vertices, are then organized in ascending order based on their angle sequence. This arrangement of vertices, distinguished by their scalar values, encodes specific features of the scan body into a 2D format. To achieve a fully standardized format-matrix, nearest-neighbor interpolation was applied to the vertices. After further normalization images were analyzed using Shannon entropy and image histograms. For the classification problem concerning each image type, Gradient Boosting Classifiers were utilized. Results: The accuracy estimate for latitude angles demonstrated the most contrasting outcomes based on entropy, with E4 and PRIMESCAN exhibiting the lowest entropy values (<3 bits). In contrast, the remaining scanners showed values above 3.5 bits. The entropy of the shape index presented similar results, with values exceeding 5 bits for all scanners, except for E4, which was at 4.8 bits. In terms of classification performance, the entropy of the Voronoi cell area provided the most distinguishable results. Histogram-based classification achieved accuracies of 0.86 for the longitudinal angle, 0.89 for the shape index, and 0.92 for the Voronoi cell area. Conclusions: Employing image-based representations of scan bodies for the classification of scanners allows for an effective comparison of relative accuracy among them or with known dimensional shapes.

PO-17

Multi-input CNN based Classification of EEG and NIRS signal during voluntary hand movement

Puwadej Leelasiri[1], Reon Takahashi[1], Fumitaka Aki[2], Hiroshi Ohshima[2], Kiyoyuki Yamazaki[2]

[1]Graduate School of Engineering, Department of Biomedical Engineering, Tokai University, Japan

[2]School of Engineering, Department of Biomedical Engineering, Tokai University, Japan

The brain-computer interface (BCI) is a popular communication method between the brain and computer or electronic devices. An electroencephalography (EEG) signal is a

popular way to create a traditional BCI system. However, when the brain signal from EEG is sensitive and inter-feres with external and internal noise, the system design is complicated, and Malfunctions may occur in the BCI system. Near-infrared spectroscopy (NIRS) that is strong in external noise supports EEG work in BCI systems. However, the sampling frequency from two of these artifacts is significantly different. It needs some complicated process to combine them or design a system that considers the characteristics of both data. This study examines the system design with a flexible convolutional neural network (CNN) setting to reduce the effect of differences in sampling frequency for the significant accuracy classification of the movement side of left- and right-hand movements by using raw EEG and NIRS data on multi-input CNN. In this study, nine healthy right-handed participants between the ages of 20 and 30 performed studies involving human participants in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Review Board of Tokai University. None of the experimental participants have ever used the BCI. Participants were seated comfortably and squeezed left and right hands Separately to measure EEG and NIRS during hand squeezing. Each participant's EEG and NIRS waveforms were averaged to observe the appearance of RP and cerebral blood flow before input into the proposed model. In this study, input size on EEG and NIRS was set at 7x250x1 and 4x20x1. Kernels size and stride on each input was set differently before combine to classify. This model was trained using 80 epochs with 0.005 learning rate and 16 mini batch size. According to the result, the proposed model could make classifying a task with 90 percent accuracy on the participant-dependent 9-fold cross-validation method possible. Therefore, the proposed model can classify a label with high accuracy. The multi-input CNN model makes it possible to support utilization in BCI systems about artifact problems such as temporal resolution. EEG is superior to NIRS in estimating the localization of brain function. On the other hand, NIRS is better at estimating relative changes in blood flow. Creating a system that exploits both advantages is essential for BCI applications.

PO-19

Combining quantitative MRI, fluorescence, and neuropathology in frameless brain tumor needle biopsies

Elisabeth Klint, Anders Tisell, Ida Blystad, Martin Hallbeck, ***Teresa Nordin***, Johan Richter, Karin Wårdell

Linköping University, Sweden

Introduction: Quantitative MRI (qMRI) holds the promise of probing tissue microstructure non-invasively but has been limited by long acquisition times and incomplete validation with standard techniques. Recently, multidimensional multi-echo MRI sequences have enabled acquisition and calculation of relaxometry maps within clinically acceptable times. Our group has previously set up a workflow for acquisition of tissue fluorescence during frameless brain tumor needle biopsies. The fluorescence measurements were included in a pipeline combining analysis of pre-, intra- and postoperative imaging data with neuropathological assessment. This study aimed to add qMRI to the workflow and compare the findings with fluorescence and neuropathology in the biopsied volume.

Methods: Ten patients undergoing tumor needle biopsy were included (EPM 2020-01404). In addition to the clinical MRI navigation protocol (3T, Siemens, Healthineers, Germany), qMRI multidimensional multi-echo imaging (voxel size = 0.7x0.7x4 mm3; slice gap 1 mm) was acquired before and after gadolinium (Gd) administration. From the qMRI sequence, synthetic images and R1 relaxation rate maps were calculated (SyMRI v0.45.38, SyntheticMR AB, Sweden). During surgery, neuronavigation (StealthStation S8, Medtronic Inc, USA) with real-time measurements of 5-aminolevulinic acid-induced fluorescence was performed using an in-house developed system and probe. After surgery, postoperative CT or MRI were acquired.

Processing was done in Python utilizing a wrapper (Nipype) including FMRIB's Software Library and Advanced Normalization Tools. The pipeline includes corrections for magnetic field inhomogeneities, skull stripping, and registration (either rigid or affine) to the clinical T1w-Gd image space, i.e., the image used for neuronavigation during surgery. The final biopsy volume was defined on postoperative imaging. The defined volumes were transformed to native R1 and R1Gd space. Median and interquartile range of the voxel values were compared, and the corresponding fluor-

escence signals extracted.

Results: Eight biopsy volumes showed 5-ALA-induced fluorescence and contained tumorous tissue. Final neuropathological diagnoses were seven glioblastomas and one lymphoma. R1 values (median (IQR)) in the tumorous volumes were 0.68 s-1 (0.48-0.87) before and 1.1 s-1 (0.83-1.4) after Gd. In the two non-tumorous volumes, R1 values were 0.66 s-1 (0.56-0.76) before and 0.79 s-1 (0.73-0.88) after Gd and no 5-ALA-induced fluorescence was found.

Conclusion: A workflow for combined analysis of qMRI, fluorescence, and neuropathological assessment was implemented for frameless brain tumor needle biopies. Through this combination, further insights on tissue microstructure could be gained beyond what is available with clinical MRI.

PO-21

Indoor Natural Ventilation Assessment in Healthcare Facilities in Low-Resource Setting

Nahimiya Husen Ibrahim, Vincenzo Piemonte, Leandro Pecchia

Università Campus Biomedico di Roma, Italy

In low-resource settings (LRSs), keeping adequate ventilation in healthcare facilities is essential for ensuring air quality and preventing healthcare-associated infections among patients, healthcare workers, and visitors. While the World Health Organization (WHO) has established ventilation guidelines, implementing effective ventilation assessment systems in LRSs remains challenging. Utilizing natural ventilation strategies, such as opening windows and using architectural design to promote airflow, can significantly and cost-effectively improve indoor air quality in resource-limited healthcare facilities. This study addresses the need for affordable and practical methods to assess ventilation in such settings.

Ventilation assessment was tested within the Plexiglas box-controlled environment by using the mass balance equation of the concentration decay method of tracer gas (ethanol), which poses no risk to patients' health. The tracer gas sprayed the substance into a room model designed from a box with various openings and measured its dispersion using a sensor characterized by high sensitivity to the gas molecule. Real-time ventilation rate and air change, as well as the number of people allowed in the room, will be processed by the microcontroller using the open-platform Arduino IDE, and the reading and analysis will be sent to the smartphone via the Bluetooth app. Finally, the ventilation rate is compared with WHO guideline reference values, which are a minimum of 60 L/s per patient.

The small-scale box test was conducted in a box with a volume of 10.692L that was used as a single-zone study area, which has different openings mimicking the real environment and has different small windows and doors. A fan is used to mix the tracer gas during the saturation phase. And when the saturation point is reached, it will be stopped, the window and door of interest opened, and the discharge phase measured by the device we have designed. We also measured the speed of air flow by using an anemometer to compare the result, which is strongly in agreement with WHO guidelines.

Preliminary findings from a study on healthcare facility ventilation systems suggest using tracer gas dispersion analysis for real-time monitoring and optimizing ventilation. This method offers a simple way to estimate ventilation performance without complex systems, emphasizing data-driven decision-making to improve ventilation strategies and enhance infection control in low-resource healthcare settings.

PO-23

Towards Equity in Healthcare: Designing an Affordable Spirometer for Low-Resource Settings

Pedro Checa Rifa, James Wallace, Davide Piaggio

University of Warwick, United Kingdom

Pulmonary diseases contribute significantly to global mortality, accounting for almost 4 million deaths in 2016. Within this staggering number, 90% of them occur in low- and middle-income countries, highlighting the clinical need for the design and development of an affordable and frugal spirometer, capable of accurate measurements whilst providing enough resilience to withstand the conditions encountered in such settings.

Currently, over 75% of the medical device use can be accounted for by less than 15% of the world population, suggesting inequitable healthcare access. Nonetheless, the right to health is a fundamental right of every human being, as recognized in the World Health Organization Constitution of 1948. This right is also at the basis of Goal 3 of the United

Nations Sustainable Development Goals, published with the aim of "leaving no one behind". This unequal situation can be further undermined by the expected exponential growth in terms of populations of low- and middle-income countries.
The primary focus of this project is to enhance the set of medical devices available for respiratory tract diseases and conditions in low-resource settings, with a specific focus on those in low-income countries and lower-middle-income countries.
The device was designed following the user and expert-driven contextualised approach, with a commitment to sustainable and environmentally-conscious ethos. The device was developed based on Arduino, a differential pressure sensor MPX5500DP, Matlab, and 3D-printed parts, relying on Bernoulli's principle. Usability studies and risk assessment and management were performed based on IEC62366 and ISO14971 and guided the design phase. The device was tested for accuracy performing tests both with a pump and subjects.
The poster will present the results of this project.

PO-25

Efficacy of a virtual reality–based video game intervention for individuals with schizophrenia spectrum disorder

Jen-Suh Chern[1], Yu Yang[2], Yi-Ching Tsai[1]
[1]National Taiwan Normal University, Taiwan
[2]Tri-Service General Hospital Beitou Branch, Taiwan

The purpose of this study was to examine the effects of immersive virtual reality action video games (IVRAVGs) and tabletop virtual reality puzzle VGs (TVRPVGs) on cognition, motor function and self-efficacy of schizophrenia patients. This study was conducted in two hospitals. Patients from hospital A underwent an IVRAVG training (Audioshield, table tennis and tennis), while those from hospital B underwent a TVRPVG training (Brain Age and Puyo Puyo). Each hospital has its own matched participants in experimental and control groups. The training regimen of both hospitals was three 40-minute sessions each week for 12 weeks. Time to complete Color Trails Test 1 and 2, number of blocks moved with dominant and non-dominant arm in Box and Block test (BBTD and BBTND), distance reached in Functional Reach Test (FRT), time to complete Timed Up-and-Go Test (TUG), and scores of General Self-Efficacy Scale (GSES) were measured 1 week before and after training. The Mann–Whitney U test was used for continuous variables, Fisher's exact test was used for variables with two categories, and Kruskal–Wallis H test was used for variables with three categories, to compare the difference of demographics between the experimental and control groups. A Wilcoxon signed-rank test was used to compare the difference of outcome measures before and after training for each group in two Hospitals. The results revealed that immersive video games, including action and puzzle videogames, and real-world activities incorporating whole-body physical activities had a positive and significant impact ($p < 0.05$) on the cognitive function, self-efficacy, motor function, and balance of the schizophrenia patients. Among the different interventions, IVRAVGs were the most beneficial for cognitive function, followed by conventional real-world interventions incorporating physical activities. TVRPVGs and conventional sedentary-only interventions had the weakest effects on the measured outcomes ($p > 0.05$). The effects of interventions that primarily involved sedentary activities may have had weak effects and, in some cases, even negative effects on outcomes such as balance ability.

PO-27

Range of Motion and Morphological Characteristics of the Sacroiliac Joint

Seonjin Shin, *Dai-Soon Kwak*
The Catholic University of Korea, Korea, Republic of

The aim of this study is to investigate how the morphological characteristics of the auricular surface may influence the SIJ range of motion (ROM) to improve the diagnosis and treatment of SIJD.
We measured SIJ ROM using motion-analysis cameras in 24 fresh cadavers of Korean adults (13 males and 11 females). Using three-dimensional renderings of the measured auricular surface, we investigated the correlations between the morphological characteristics of the auricular surface and the ROM of the SIJ.
The SIJ ROM was between 0.2° and 6.7° and was significantly greater in females (3.58° ± 1.49) compared with males (1.38° ± 1.00). Dividing the participants into high-motion (3.87° ± 1.19) and low-motion (1.13° ± 0.62) groups based on the mean ROM (2.39°) showed no significant differences in any measurements. Ad-

ditionally, bone defects around the SIJ were identified using computed tomography of the high-motion group. In the low-motion group, calcification between auricular surfaces and bone bridges was observed.
The morphological characteristics of the auricular surface do not affect SIJ ROM, which was greater in females than in males. In terms of auricular surface measurements, including width, height, inferior length, superior area, inferior area, total area, and surface medial groove, males had significantly larger values than females ($p < 0.05$). However, when comparing the high-motion and low-motion groups, there was no significant difference in shape, size, and overall morphology of the auricular surface. This study provides valuable insights into the differences in SIJ ROM between females and males, as well as the anatomical structures surrounding the SIJ that influence its ROM. Our findings have the potential to contribute to the enhancement of SIJD diagnosis and treatment.

PO-29

Effect of friction coefficient on subsidence of cemented polished stem in THA

Noriyuki Takano[1], Yuuta Nakajyou[1], Ayumi Kaneuji[2]
[1]Kanazawa Institute of Technology, Japan
[2]Kanazawa Medical University, Japan

It is well known that cemented polished tapered femoral stems are stable by their subsidence, but a risk factor for periprosthetic fracture increases by compressive stress induced by the subsidence. The subsidence is affected by the friction between stem and cement, which depends on their materials and surface condition. The present paper used the nonlinear finite element method to estimate the effect only of the friction coefficient between stem and cement on the subsidence and stress of cement mantles. A polished tapered stem, which was assumed to be made of titanium alloys, was inserted into a femur model truncated femoral head from CT data of a female patient with hip osteoarthritis. A cement mantle layer was made between the stem and the femur model. The cement layer and the femur were fixed. The friction coefficient between the stem and the cement mantle varied from 0.1 to 0.9. The static load 1817 N was applied to the tip of the head at 15° downward to the bone axis. The subsidence of the stem increased as the friction coefficient. Compressive stress to cement mantle showed a similar tendency. It was strong at the distal area from the femoral head. Thus, the present results indicate that a risk factor for periprosthetic fracture is high in the cemented polished tapered femoral stems, of which the friction coefficient is small. In the future, the response will be investigated for cyclic loads.

PO-31

Effect of Tissue on Stress-Strain Characteristics of Pulmonary Pleura

Hitomi Sakai[1], Hirosane Hayashi[1], Sumiko Maeda[2], Noriyuki Takano[1]
[1]Kanazawa Institute of Technology, Japan
[2]Dokkyo Medical Univercity, Japan

Primary spontaneous pneumothorax is caused by the breakdown of the brevis, which occurs when the visceral pleura is detached from the lung surface. Although the mechanism by which the brevity occurs has not yet been elucidated, it has been reported that it often occurs at the apex of the lung, suggesting that not only the shape and characteristics of the lung itself, but also the mechanical properties of the pleura of the lung may have an effect. Although there have not been many studies on the mechanical properties of the lung, it is known that the stress-strain characteristics of the lung pleura show nonlinear changes due to the influence of elastin and collagen, and that it is generally isotropic. However, in the tensile test of porcine visceral pleura conducted in this study, the results varied greatly depending on the direction of loading, confirming anisotropy. Tissue residue was observed on the surface of the specimens used in the tensile test. There is connective tissue between the lung parenchyma and the visceral pleura. We expected that the interlobular septa connected to this tissue would remain on the pleural side when the visceral pleura was peeled off from the lung to prepare the specimens, and thus affecting the measurement results. The residual microstructure and the anisotropy of the stress-strain curves in each of the tensile test specimens were therefore checked. Therefore, the residual microstructure and the anisotropy of the stress-strain curves in each of the tensile test specimens were checked. The results showed that the anisotropy of the pleura is influenced by the residual microstructure on the surface of the specimen, while the pleura itself is isotropic.

PO-33

Evaluation of the biocompatibility of interface-free polymer-ceramic fusion technology using laser-driven penetration synthesis

Minseong Chae[1], Kang-Sik Lee[1], Yu-Chan Kim[2], Hojeong Jeon[2], Seung-Hoon Um[2], Hwachul Jung[3], Dongkyu Koo[3], Dong-Ho Lee[1]

[1]University Of Ulsan, Korea, Republic of

[2]Korea Institute of Science and Technology (KIST), Biomaterial Research Center, Korea, Republic of

[3]Innosys Co.,Ltd., R and D, Uijeongbu, Gyeonggi-do, Korea, Republic of

Bioactive hydroxyapatite (HA) coated implants on inert Polyether ether Ketone (PEEK) substrates are widely utilized in orthopedic intervertebral disc prostheses and joint replacements. However, the adhesion of HA coatings to PEEK surfaces is hindered by a known weakness in the bond between the two materials, resulting in frequent delamination.

In an effort to address this issue, a specialized nanosecond laser-based process was utilized to synthesize interface-free HA/PEEK surfaces. This method involves the controlled melting of the PEEK interface, enabling the coexistence of HA and molten PEEK.

As a result, a robust bond forms between the implant and bone interface, preventing the detachment of the coating after it is implanted. The primary objective of this study was to assess the bonding strength of interface free PEEK specimens within a rabbit model. Thin rectangular samples (5 x 8 x 1 mm) of HA/PEEK and pure PEEK, manufactured using a laser fusion process, were bilaterally implanted into the tibia tuberosity of New Zealand White Rabbits (2.5 kg).

Following an 8-week observation period, the rabbits were euthanized, and Micro CT imaging was used to examine the implant and bone interface. Subsequently, tissue morphometric analysis was conducted around each implant site using Goldner's trichrome stain.

The results demonstrated that the bone-to-implant contact (BIC) for HA/PEEK was 32.778%, while pure PEEK achieved a BIC of 20.637%. Consequently, the HA/PEEK grafts exhibited a 12.141% higher BIC value than pure PEEK, highlighting the superior bonding strength of the HA/PEEK interface.

PO-35

Dual growth-factors delivery (VEGF and BMP-2) with alendronate improve cell adhesion in osteoinductive bone repair

Amira Raudhah Abdullah[1], Mohd Riduan Mohamad[2], Ka Liong Tan[1], Nadia Mohd Effendy[1], Nur Nabilah Abu Bakar[1], Intan Maslina Musa[1]

[1]Universiti Sains Islam Malaysia (USIM), Malaysia

[2]Universiti Teknologi Malaysia, Malaysia

The dynamic mechanisms inherent in bone homeostasis yield invaluable insight for advancing scaffold biomaterials in bone regeneration. The increasing recognition of drug delivery systems and the release of bioactive substances is significantly elevating their importance in bone tissue engineering. This approach not only supports bone tissue formation but also enhances the scaffold's ability to facilitate bone ingrowth. Bisphosphonates (BPs) play a crucial role in bone remodeling subsequently affecting bone regeneration. Despite this, there is a scarcity of studies addressing the systematic delivery of BPs within bone defect models. In this study, integration of bisphosphonates pamindronate (Pam) and alendronate (Aln) into a hydroxyapatite (HA) scaffold with MC3T3-E1 cells and growth factors (VEGF and BMP-2), is expected to yield a synergistic effect, intensifying osteoinduction and efficient bone regeneration. Cell viability was measured using 2,5-diphenyl-2H-tetrazolium bromide (MTT) assay and morphological assessment was documented using the inverted microscope. Characterization of engineered HA scaffold was performed using Field emission scanning electron microscopy (FESEM), and its elemental analysis was done using energy-dispersive X-ray (EDX) analysis. The mineralization rate was assessed by analysing alkaline phosphatase (ALP) expression. Data demonstrated that Aln offers better potency on osteoblast cells as compared to Pam. FESEM micrograph revealed that the engineered HA-VEGF+BMP-2/Aln scaffold facilitated osteoblast attachment and spreading, forming a concrete connection with HA scaffold. Engineered HA-VEGF+BMP-2/Aln also significantly increased ALP expression, indicating that the extracellular matrix is advancing into the mineralization phase. To conclude, our investigation unveils the synergistic effects of combining dual growth factors (VEGF and BMP-2) with BPs, specifically Aln, resulting in enhanced cell adhesion on hydroxyapatite scaffolds. This emphasizes the substantial promise of employing such a strategy in pro-

moting the regeneration of bone tissue.

PO-37

Cardiac Hypertrophy Simulations Using Echocardiography-based LV Model

Bogdan Milicevic[1], Miljan Milosevic[2], Milos Kojic[2], Nenad Filipovic[1]

[1]Faculty of Engineering, University of Kragujevac, Serbia

[2]BioIRC, Serbia

In our research, we introduced the utilization of shell elements in creating left ventricle models based on echocardiographic data. We conducted simulations to analyze the effects of cardiac hypertrophy and monitored the progression of the disease. Hypertrophy affected changes in both wall thickness and displacement field, which we adjusted to reflect hypertrophic effects. Using our left ventricle models, we simulated both eccentric and concentric hypertrophy effects and observed alterations in ventricle shape and wall thickness. Concentric hypertrophy led to wall thickening, whereas eccentric hypertrophy resulted in wall thinning. To represent passive stresses within the left ventricle model, we employed a recently developed material model based on Holzapfel experiments. Additionally, our specialized shell composite finite element models allowed for more efficient simulation of heart mechanics compared to conventional 3D models. Furthermore, our approach to modeling echocardiography-based left ventricle mechanics can be applied practically, as it relies on patient-specific geometry and experimental constitutive relationships. Our model provides insights into hypertrophy development in realistic heart geometries and offers potential for testing medical hypotheses regarding hypertrophy evolution from a healthy state to disease progression, under various conditions and parameters.

Acknowledgement: The research was supported by the STRATIFYHF project that has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101080905. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or granting authority - European Health and Digital Executive Agency (HADEA). Neither the European Union nor the granting authority can be held responsible for them. This research was also supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, contract number [451-03-65/2024-03/200107 (Faculty of Engineering, University of Kragujevac) and 451-03-66/2024-03/200378 (Institute of Information Technologies, University of Kragujevac)]. The authors acknowledge support from the City of Kragujevac, Serbia.

PO-39

Evaluation of brain activity using NIRS to examine the antecedents of microsleep

Fumitaka Aki, Tatuhiro Kimura, Hiroshi Ohshima, Kiyoyuki Yamazaki

Tokai University, Japan

Every year, Traffic accidents caused by drivers falling asleep at the wheel are frequent on Japan's highways. In this experiment, we focused on microsleeps, which are particularly dangerous. Microsleep is sleep that goes unnoticed for a few seconds during a meeting or while driving. This type of brief, unconscious sleep is called microsleep. The purpose of this experiment is to examine whether the characteristics of microsleep and its precursors can be detected from Brain activity in frontal lobe regions. Brain activity in frontal lobe regions is assessed using near-infrared spectroscopy (NIRS). The NIRS device has a simple structure that can be worn like a headband and is very lightweight, so it does not impose a burden on the user. First, volunteers were instructed to sit on a chair with the NIRS device on. Volunteers were than presented with a less informative video. The experiment was terminated when microsleep was visually observed. Cerebral blood flow variations obtained from 10 volunteers were additionally averaged and graphed. As a result, a characteristic spike-like waveform was observed 100 seconds before the onset of microsleep. Furthermore, the waveform at a distance of 3 cm showed greater cerebral blood flow variability than that at a distance of 1 cm. This spike-like waveform corresponds to behavior resisting drowsiness and is considered a precursor to dozing off. Since unconscious anti-drowsing behavior is an activity of the hypothalamus and other deep brain regions, blood flow at a distance of 3 cm may be increased. By detecting such spike-like waveforms with NIRS, the antecedents of microsleep can be determined. However, the large individual differences in these waveforms make classification based on nonadditive data difficult. The future challenge is to improve the accuracy of NIRS detection and microsleep identification using AI

and apply it to the field of traffic safety.

PO-41

An IoT-based Medication Calendar for Home-Visiting Nursing

Yasushi Yamauchi, Junto Hosono
Graduate School of Science and Engineering, Toyo University, Japan

Introduction: Home-visiting nurses play a coordinating role in determining the appropriate method of medication administration based on symptoms and reporting it to the physician, and also in collaboration with people in other professions and patients' families. However, nurses cannot be present at all times of the day to administer medications to their patients, they do not have a complete grasp of their medication status. Previous works to solve this problem include a medication support robot (CareBot) and a smart medication system (WW. Chang et al.), that can automatically record medication information. Both systems require the nurse to place the medication in dedicated container.
Purpose: Medication calendars are commonly used for medication management in in-home nursing care. We propose an IoT-based medication calendar system that records medication information of home care patients as online data and sends notifications to nurses. Specifically, a photo reflector is attached to each compartment of the medication calendar, to detect whether and when medication has been taken.
Methods: A 3D printer and an acrylic board were used to fabricate the medication calendar, with each compartment designed with a slope so that the medication slides down to the center, without any dedicated container. A photo reflector is mounted on the center of each compartment, to detect whether the medication is taken or not. In this study, the system manages a week's worth of medications (morning, noon, and night) and identifies 21 doses of medication. Accordingly, 21 photo reflectors are used.
When the medication is taken out, two microcontrollers (Arduino MKR WiFi 1010) record and send the medication information to a Google Drive spreadsheet via IFTTT. In addition, the contents are notified to the nurse's optional e-mail address.
Results: Of the 15 types of counterfeit medicines and medicine packages, our system recognized 13 counterfeit medicines and packages successfully. Two translucent packages were not correctly recognized if it was separated by more than above 5 mm from the photo reflector. We confirmed that the medication information was recorded in a Google Spreadsheet when the medication was taken out, and that the information was automatically updated depending on whether the medication was taken correctly or not. We also confirmed that the system sent a notification corresponding to the correctness of the medication. Our system is expected to strengthen cooperation among nurses, doctors, and other medical professionals.

PO-43

Investigation of the use of 3D modeling and predictive analysis for optimizing the management of the Miljacka River

Madžida Hundur, Merima Smajlhodžić-Deljo, Faruk Bećirović, Naida Babić Jordamović, Lejla Gurbeta Pokvić
Verlab Research Institute for biomedical engineering, medical devices and artificial intelligence, Bosnia and Herzegovina

Introduction & Aim: Recent advancements in hydrological modeling technology offer a promising avenue for optimizing management strategies aimed at enhancing the sustainability of aquatic ecosystems, such as the Miljacka River. Employing advanced modeling techniques for precise visualization and simulation of river hydrology emphasizes the significance of understanding pollution sources and their impact on aquatic ecosystems, specifically focusing on the Miljacka River in this study. The aim of the study is to utilize three-dimensional (3D) modeling technology to identify pollution hotspots, assess their causes, and propose remediation strategies, ultimately promoting the sustainability of the river's aquatic ecosystem.
Methods: Initially, a two-dimensional (2D) model based on satellite imagery was created to provide a foundational understanding of the river's hydrology. This 2D model was then upgraded to a more sophisticated three-dimensional (3D) model using tools like SketchUp, Revit, and Twinmotion. The process involved integrating topographic characteristics and physical data, including length, width, and depth of the river. Additionally, the methodology included mapping significant pollution areas along the riverbed, particularly from City Hall to Otoka, to identify pollution hotspots. The identification of these hot-

spots involved a thorough analysis of potential pollution sources.
Results: The analysis reveals that these hotspots are primarily caused by streams and collectors, highlighting the importance of accurately pinpointing pollution sources for effective remediation. Furthermore, the study demonstrates the capability of 3D modeling to provide detailed insights into the river's hydrology, facilitating the identification of optimal sites for algae colonization for bioremediation purposes.
Conclusion: This strategy provides an effective approach to water purification and preservation of aquatic life. This research not only provides a foundation for an extensive database that enhances the understanding of river pollution but also increases awareness of the vulnerability of aquatic life, crucial for the development of a sustainable water resource management strategy. Healthy aquatic ecosystems are vital for supporting biodiversity and ecosystem services, which in turn can have indirect impacts on human health. The implications of this research extend to the field of water resource management, encouraging the exchange of knowledge and information among experts dedicated to improving the sustainability of aquatic ecosystems.

PO-45

The Development of Medical Imaging in China and Its Impact on the Clinical Practice

Kui Cai[1], Guobin Li[2], Junan Zheng[2], Lei Chen[2], Qing Mao[2], Ruixin Jiang[2], Shuheng Zhang[2], Taomin Zhang[2], Wenjing Ma[2], Xiaoyue Gu[2], ***Ying Qian***[3]

[1]Beijing Hospital, China

[2]Shanghai United Imaging Healthcare Co., Ltd., China

[3]Jiangsu Province Hospital, China

Thanks to growing innovations and discoveries, medical imaging devices have been widely used not only as a diagnostic tool for diseases, but also used to treat, manage, and predict illnesses in clinical practice. During this process, radiologists are facing many challenges, for instance, "how to achieve high-resolution imaging", "how to get scanning done faster ", and "how to make the system more user-friendly". To address these issues, imaging practitioners from China have got certain positive results through a series of new products design, development, manufacturing with advanced technology.In the field of magnetic resonance, the world's first whole-body ultra-high-field 5T MRI, uMR Jupiter, has brought microscopic-level high-resolution imaging of the whole body, achieving the clinical ability to "see the unseen" and leading the forefront exploration in precision medicine. By integrating AI into the scanner, the MRI achieves ultra-fast imaging, ultra-high resolution, and a fully intelligent workflow, helping to enhance diagnostic capabilities and productivity.
In the field of molecular imaging, the world's first total-body PET/CT scanner, uEXPLORER, which is known as the "Hubble Telescope" for the human body, has led the international wave of total-body PET technology and expanded the application boundaries of nuclear medical imaging. By integrating AI into PET/CT, the capabilities of low noise and high contrast can be empowered to other clinical systems, further promoting the technological evolution and exploring clinical panoramas of the nuclear medicine industry.
With AI-empowered technologies, CT scanner offers precise imaging and ease of use throughout the entire clinical spectrum, including functions such as smart patient positioning, AI empowered iterative reconstruction, and AI empowered motion correction. These functions greatly expand the boundaries of clinical practice and makes the impossible possible such as One-beat Cardiac Solution and ultra-low-dose solutions.
In addition to enhancing the capabilities of all full-modality medical imaging and treatment equipment, AI also has great application value and exploration prospects in clinical quality control and scientific research such as clinical data man agement, versatile annotation tools, and advanced research tools.
In summary, the progress in clinical practice and the advancement of medical imaging impact and improve each other, and we believe that they will help patients to healthier lives and contribute for human health enterprise through numerous technological innovations and new findings from clinical studies.

PO-47

An explainable XGBoost model to predict pediatric sleep apnea resolution after treatment from new phenotypic information

Gonzalo C. Gutiérrez-Tobal[1], Javier Gomez-Pilar[1], Daniela Ferreira-Santos[2], Pedro Pereira-Rodrigues[2], Daniel Álvarez[1], Félix del Campo[1], David Gozal[3], Roberto Hornero[1]

[1]Universidad de Valladolid and Centro de Investiga-

ción Biomédica en Red en Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN),, Biomedical Engineering Group, Spain
[2]CINTESIS@RISE, MEDCIDS, Faculty of Medicine of the University of Porto, Porto, Portugal
[3]Joan C. Edwards School of Medicine, Marshall University, United States

Pediatric obstructive sleep apnea (OSA) causes recurrent breathing pauses during the night of the affected children, termed apneas and hypopneas. These apneic events lead to an inadequate gas exchange and, eventually, fragmented and restless sleep. Up to 5.7% of children are suggested to be affected by OSA, hampering their normal development, and leading to neurocognitive affectation, decreased quality of life, and increased risk for cardiovascular diseases. However, children show a heterogeneous range of symptoms and responses to treatment, being OSA phenotypes, not yet completely understood, one plausible reason for these differences. A recent study automatically defined 3 new pediatric OSA phenotypes with different odds of recovering after treatment based on 26 anthropometric and clinical features. In this study, the objective is to use the new phenotypic information to predict before treatment (surgical removing of tonsils and adenoids) whether a child will recover from OSA after treatment. Accordingly, we used data from 199 children (5-10 years old) to train and validate a Gentle Adaptive Boosting ensemble model (XGBoost implementation). We also used the relative importance of the variables to conduct an explainable artificial intelligence (XAI) analysis. A leave-one-out cross-validation method was used for hyperparameter optimization (15 decision trees), and a bootstrap 0.632 method was used for performance evaluation. Our results showed 79.4% Sensitivity (69.9-88.0?% confidence interval), 65.0% Specificity (51.7-77.3 95% CI), 77.8% Positive Predictive Value (70.3-86.0?% CI), and 66.5% Negative Predictive Value (58.0-76.2?% CI) in predicting OSA resolution after treatment. Moreover, oral anatomy (Mallampati score), obesity (body mass index), age, and gasp and chokes presence during the night were highlighted by XAI as the most relevant features for the model predictions, showing a minimum of 10% (gasp and chokes) and a maximum of 18% (Mallampati score) of relative importance. Accordingly, we conclude that the information from the new phenotypes can be used to help predict whether a child will respond to surgical removing of adenoids and tonsils in the context of pediatric OSA. Furthermore, both anatomical and clinical characteristics are relevant to conduct these predictions.

Grants. This research has been developed under the grants PID2020-115468RB-I00 and PDC2021-120775-I00 funded by 'Ministerio de Ciencia e Innovación/Agencia Estatal de Investigación/10.13039/501100011033/' and ERDF, A way of making Europe; and by 'CIBER en Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN)' through 'Instituto de Salud Carlos III' co-funded with ERDF funds.

PO-49

Analysis of age-related variations in photoplethysmography: a Machine Learning approach

Sara Lombardi, Federica Tavernise, Piergiorgio Francia, Leonardo Bocchi
University of Florence, Italy

Vascular aging is an important indicator in cardiovascular risk assessment. In this study, we used a machine learning approach to estimate the cardiovascular age of subjects using the photoplethysmographic signal (PPG). From PPG, acquired in 115 healthy subjects aged 18 to 66 years, we extracted a set of morphological features and Heart Rate Variability parameters. These parameters were used in a cross-validation approach to predict the cardiovascular age of the subjects using the GradientBoostingRegressor algorithm. Quantitative performance evaluation showed promising results, yielding a mean absolute error of (6.81 ± 0.86) and a coefficient of determination equal to (0.44 ± 0.22). Using the SHAP method, we determined the impact of features on model performance by identifying heart rate change, low signal frequencies, and systolic phase velocity as the most significant parameters. These findings improve our understanding about the influence of age on the PPG signal, offering potential insights for future clinical applications in cardiovascular risk prevention.

PO-51

Influence of fatigue in swimmers suffering from swimmer shoulder pain

Alessandra Raffini, Alex Buoite Stella, Miriam Martini, Laura Mazzari, Agostino Accardo
University of Trieste, Italy

The shoulder joint is susceptible to be damaged in sports with overhead actions, often leading to swimmer shoulder pathology. Fatigue can also worsen and in-crease the risk of overuse injuries. Evaluating shoulder kinematics during swimming is crucial to identify injury-related movement patterns and to provide a correct physiotherapy treatment. To measure kinematics, inertial and magnetic measurement systems (IMMSs) offer a very versatile approach with respect to traditional video-based systems. This preliminary study focuses on the effects of fatigue on shoulder joint kinematics in swimmer with swimmer shoulder compared to healthy swimmers, by using IMMS. 11 young swimmers (5 pathological, 7 male) took part in the study. Each participant executed 40 seconds of dry front crawl followed by a fatiguing protocol and by other 40 seconds of dry front crawl. We analyze the arm movement relative to the thorax examining the differences of the movement amplitudes between healthy and pathological subjects and before and after fatigue exercise according to the three rotations: Flexion/Extension, Abduction/Adduction, and Internal/External rotation. Some slight non-significant differences were found after exercise compared to before in all the three rotations while a significant difference between healthy and pathological subjects was found in Flexion/Extension rotation both before and after fatigue exercise. The use of IMMS allowed to verify the repeatability of the kinematic movement and to quantify the rotation angles identifying which component of the movement is most affected by the swimmer shoulder pathology. However, a larger number of subjects is necessary in order to confirm the results.

PO-53

Semi-Automated Approach to Analyze the Tapering of Coronary Vessels from Contrast-Enhanced Micro-CT Scans of Human Coronary Artery Anatomy

Amanda DeVos, Paul A. Iaizzo
University of Minnesota, United States

Coronary artery anatomy must be taken into consideration when sizing percutaneous coronary intervention (PCI) devices, including stents and dilation balloons. It is well documented that all coronary vessels taper; however, the locations and variability of such tapering has not been reported. Typically, stents are sized to the distal main vessel, and a proximal optimization technique (POT) is performed with a larger diameter balloon to ensure that there is no malapposition at the proximal area of the stent. Intracoronary imaging can be used to determine the proximal and distal diameters of the vessels of interest; however, today this advanced imaging is only used in approximately 13% of PCI procedures. Therefore, it is important to understand common human coronary anatomies and relative presentations of such tapering to avoid over-expanding the given vessel, which can cause dissections or rupture. The Visible Heart Laboratories® receives human heart donations, and these hearts are fixed in an end-diastolic state, such that the coronaries remain patent. Following fixation, the left and right coronary ostia were cannulated with venogram catheters, and contrast was injected into the coronaries. Each heart was then micro-CT scanned (~80-micron resolution), and the 3D scans were reconstructed. The coronary arteries were segmented within Mimics software, and centerlines were generated for each artery including the left main, left anterior descending (LAD), circumflex, and right coronary artery (RCA) and their associated branches. Next, an automated program was used to measure and record the cross-sectional diameters and corresponding locations of all the points along each centerline, and to calculate the rates of tapering (slope of the linear regression between the diameter and distance) of each branch. To date, this semi-automated approach was successfully used to quantify the coronary artery tapering of 14 human coronary artery branches. Within this sample set, the vessels had maximum diameters between 1.5 and 3.5 mm and tapered at an average rate of 0.018 mm per 1 mm of vessel. This rate indicates that coronary arteries taper relatively slowly, which suggests that sizing up a POT balloon by 0.5 mm may not be necessary. Alternatively, using a higher pressure with same size balloon may be sufficient to account for the artery tapering. The described methodologies can also be used to build a dataset of tapering rates of coronary arteries, as well as, the cross-sectional areas and diameters of healthy coronary arteries, as future means to train programs to identify diseased vessels.

PO-55

Reliability of the SPIMON, a portable 3-D spinal range of movement measurement prototype device

Aris Dermitzakis[1], Athanasios Lampropoulos[1], Ioannis Kalamaras[1], Emil Valchinov[2], Vasileios Syrimpeis[3], Dimitra-Tania Papanikolaou[1], Evdokia Billis[1]

[1]University of Patras, Greece

[2]AEON P.C., Patras Science Park, Greece

[3]General Hospital of Patras, Greece

Measuring the range of movement (ROM) in the spinal column is crucial for diagnosing and rehabilitating spinal pathologies. Traditional methods for assessing spinal movements, such as flexion and extension, rely on sophisticated and expensive equipment that often falls short in usability, portability, cost-effectiveness, and time efficiency. This study introduces SPIMON, an innovative, wearable, and portable electronic device designed to monitor spinal ROM. SPIMON is affixed directly to the spine and communicates wirelessly with a tablet to record movement data. Our research primarily investigates the inter-examiner and test-retest reliability of SPIMON in measuring the spinal ROM of healthy subjects, with a focus on its application by novice examiners. Twenty asymptomatic participants (11 men, 9 women) with an average age of 22.74±1.4 years and a body mass index (BMI) of 22.12±2.5 were enrolled in the study. Measurements were conducted by two final-year physiotherapy students who had undergone a brief training session on the device's operation, including sensor placement and data collection. Reliability assessments involved test-retest measurements by each examiner and inter-examiner comparisons, focusing on spinal flexion, extension, and lateral flexion movements. Data analysis was performed using intraclass correlation coefficients (ICC2,1), standard error of measurement (SEM), and smallest detectable differences (SDD) through SPSS. The findings revealed excellent test-retest reliability for flexion, extension, and right-side flexion (ICC>0.91, SEM=0.87-2.37, SDD=0.86-1.68) and moderate reliability for left-side flexion (ICC=0.55 & 0.68, SEM=0.95 & 0.68, SDD=0.92 and 1.10). Inter-examiner reliability was very good across all spinal ROM measurements (ICC=0.85-0.95, SEM=1.73-2.06, SDD=1.12-1.96). However, deviations were noted in left-side flexion within a subgroup, indicating moderate ICC (0.40) with acceptable SEM (2.09) and SDD (1.35). Despite some technical challenges encountered, sensor placement and measurement processes were efficient and straightforward, highlighting areas for further refinement and potential enhancement of SPIMON's design and functionality.

PO-57

Surface electromyographic (sEMG) biofeedback device as an outcome measure for an individualized pelvic floor muscle (PFM) training program for urinary incontinent women: preliminary results

Dimitra-Tania Papanikolaou[1], *Aris Dermitzakis*[1], Emil Valchinov[2], Konstantinos Giannitsas[1], Evangelos Dermatas[1], Epaminondas Mitronikas[1], Evdokia Billis[1]

[1]University of Patras, Greece

[2]AEON P.C., Patras Science Park, Greece

Urinary incontinence (UI), defined as the involuntary loss of urine, significantly impacts approximately one-third of adult women globally, encompassing groups such as young athletes, pregnant women, and the elderly, thereby severely affecting their quality of life. Recognizing pelvic floor muscle (PFM) training as the primary therapeutic approach for UI, this study assesses the efficacy of a surface electromyographic (sEMG) biofeedback device used as an evaluative tool in a tailored, 12-week PFM training program. Ten women, aged 60.2 ± 9.8 years with a mean body mass index (BMI) of 28.8 ± 5.9, participated in this intervention, which was meticulously crafted based on individual PFM performance assessments facilitated by the NeuroTrac sEMG device. Administered by specialized women's health physiotherapists, the program's structure included an initial baseline assessment, a concluding evaluation at 12 weeks, and intermediate weekly supervised sessions. Primary outcome measures focused on several PFM parameters: endurance, measured by the average time participants could maintain a contraction at over 50% of their maximal voluntary contraction (MVC); strength, quantified through MVC in microvolts via sEMG; frequency of sustained MVCs; and the number of fast PFM contractions, maintaining greater than 80% of peak MVC values for one second. The results indicated statistically significant improvements in three out of the four primary PFM parameters. Endurance saw an increase from an average of 6.1 ± 1.6 seconds to 7.3 ± 1.2 seconds (p=0.009), the number of sustained MVCs im-

proved from 5.8 ± 1.1 to 7.3 ± 1.1 (p=0.002), and the frequency of fast contractions escalated from 6 ± 1.4 to 7.5 ± 1.3 (p=0.002). Although an increase in PFM strength was observed (from 48.3 ± 38.2μV to 53.4 ± 41.6μV), it did not reach statistical significance (p=0.55). Secondary outcomes, assessed through the Greek version of the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) and the "1-hour pad test," also demonstrated significant improvements in UI severity and urine loss, respectively, enhancing from 11 ± 5.6 to 4.8 ± 3.2 (p=0.003) and from 4.3 ± 3.4g to 0.5 ± 0.4g (p=0.008). These findings affirm the sEMG biofeedback device's utility as a potent diagnostic and monitoring tool in PFM training regimes tailored to combat UI, advocating for its broader application in clinical practices targeting similar therapeutic outcomes.

PO-59

Tempo Certo Project - Adapting EEG systems to perform Multifocal Visual Evoked Potentials for clinical care and research

Igor Telles[1], Arthur Conceição[1], Paulo Galhanone[2], Mauricio Cagy[1], Dimitri Abramov[2], *Antonio Miranda de Sa*[1]

[1]Federal University of Rio de Janeiro, Brazil

[2]Oswaldo Cruz Foundation, Brazil

Objective: Development of protocols for the acquisition of multifocal evoked potentials (mfVEP) applied to the Tempo Certo (TC) project, a portable analog device that adapts conventional electroencephalogram (EEG) equipment to perform evoked potential examinations with low cost, greater flexibility, and absolute precision, which makes it applicable both in research and in medical practice.
Methodology: The mfVEP provides local visual field VEP responses, simultaneously allowing the topological study of small parts from the retina to the visual cortex. The stimulus is a circular shift pattern, shaped like a logarithm checkboard centered on the fovea (radius=20–25o), divided into 60 sectors, with nine black/white squares each. Half of all sectors shift at a pseudorandom combination (m-sequence), ranging from 15 to 30Hz. The stimulation is provided through a media running in a suitable player. TC synchronizes the events (pattern shifts) by an eccentric probe in the screen under the TC photocell. A trigger signal is sent to the EEG recorder for each event. So, multiple individual VEP responses are generated simultaneously from the occipital EEG signal. A mathematical algorithm indexes the trigger waves according to m-sequence for averaging. It extracts the VEP response for each sector by the difference between the averaged signal where a specified sector shifts and the signal where it does not.
Twenty subjects will be recruited to test our method and device. The inclusion criteria are unilateral and local retinal lesions. The mfVEP between the eyes will be compared, inferring the accuracy of the system.
Results: The mfVEP performed by TC is specific and sensitive to detect and topographically map the functional impact of the retinal lesions, compared with the healthy contralateral eye.
Conclusion: It is possible to record functional changes in small regions of the retina and visual pathways in a non-invasive and non-expensive way, which does not occur with electroretinography (ERG) or conventional VEPs. As TC easily allows the dissemination of access to evoked potentials using EEG systems, our method will optimize the functional diagnosis and follow-up of several diseases (e.g., glaucoma, diabetes mellitus, multiple sclerosis, and other acute processes) with high precision and sensitivity.
Although neurodiagnosis has advanced substantially with the advent of neuroimaging, lower accessibility has become a significant problem worldwide due to the high cost of imaging. On the other hand, mfVEPs are very sensitive and constitute a technique that allows assessing the functionality of visual neural systems, being an alternative for screening and follow-up of patients, in accordance with policies for universalizing health systems.

PO-61

Microstates analysis for dry and gel-based multichannel electroencephalography

Hannes Oppermann, Patrique Fiedler, Jens Haueisen

Technische Universität Ilmenau, Germany

Spatial analysis of EEG data, e.g. using short-term stable microstates, is increasingly used in neuroscience and clinical applications.
At the same time, scenarios involving mobility, sports, and home-based activities are becoming more prevalent in EEG studies.
For this purpose, dry EEG electrodes are more and more commonly used.
Thus, our objective was a comparison of microstates analysis between dry and gel-

based EEGs. 256-channel EEGs were recorded from 30 volunteers using dry and gel-based electrodes during resting state eyes closed and eyes open. Microstates were extracted for each measurement and time-domain parameters were calculated.
We found a high degree of consistency between the microstate maps extracted from dry and gel-based measurements for both eyes closed and eyes open conditions. The topographic similarities between the average maps for dry and gel-based recordings were above 81.5% for each of the seven extracted maps.
We conclude that topographic microstate analyses are feasible using multichannel EEG setups with new dry EEG electrodes.

PO-63

The potential use of electroporation in combination with chemotherapeutics or calcium chloride as a therapeutic option for uveal melanoma patients: first in vitro and in vivo results

Miltiadis Fiorentzis
University Hospital Essen, Department of Ophthalmology, University Duisburg-Essen, Germany

Uveal Melanoma (UM) represents the most common primary intraocular malignant tumor in adults. Despite its high metastatic and mortality rate, a standardized therapeutic regimen has not yet been established for the consolidation of a protocol for the surgical treatment of UM.
In pursuance of novel treatment modalities, we investigated the effect of electroporation (EP) in combination with various chemotherapeutic drugs or with calcium chloride predominantly on ocular melanoma 2D and 3D cell cultures as well as in vivo in the CAM assay. Specifically four uveal melanoma (UM) cell lines were tested for the efficacy of EP in conjunction with bleomycin and cisplatin, where a higher resistance of all cell lines was noted to cisplatin. Bleomycin showed similar results at lower concentrations with electroporation conditions of 750 V/cm and 20 pulses, whereas the same effect was achieved for only two cell lines with 1000V/cm and 8 pulses with 2.5 g/ml cisplatin. In five uveal cell lines of primary and metastatic origin, used for the formation of 3D spheroids, the most significant reduction of size was observed after EP with 750 V/cm and 2.5 g/ml bleomycin. In the first in vivo results after implantation of cell pellets on the chick chorioallantoic membrane for the development of tumor organoids, no significant difference was documented in the effect of 2.5 and 1 g/ml bleomycin. Furthermore, we examined the potentiation of radiosensitivity following ECT in 3D UM spheroids.
2D and 3D UM cell cultures were electroporated with 8 pulses (100 s pulse duration, 5 Hz repetition frequency) of a 1000 V/cm pulse strength alone or in combination with 0.11 mg/mL, 0.28 mg/mL, 0.55 mg/mL or 1.11 mg/mL calcium chloride or 1.0 g/mL or 2.5 g/mL bleomycin. In addition, in vivo UM cell line-xenografts as well as patient derived tumor samples were treated. The results suggest a dose-dependent ATP depletion with a wide range of sensitivity among the tested UM cell lines, as CaEP and bleomycin electroporation significantly reduce cell viability at similar applied voltage settings.
Further investigations and the development of suitable electrodes for the eye are necessary for the establishment of EP as an adjuvant option for the advanced UM.

PO-65

Acoustic pressure analysis due to high-frequency electric field on the biological cell during reversible electroporation

Mayank Kumar, Rochish Thaokar
Indian Institute Of Technology Bombay, India

The biological cells when exposed to an electric field undergo electrodeformation parallel to the direction of the applied electric field. This electrodeformation produces acoustic pressure waves in the extracellular fluid which could be measured by the pressure transducers. The multiphysics investigation on this deformation and acoustic pressure produced during reversible electroporation is proposed using different cell contours. The transmembrane potential, total elastic strain energy, Maxwell stress tensor(MST) and Helmholtz wave equation in the cell are compared using multiphysics for action under unipolar and bipolar nano-pulse electric fields. The polarization of cervical cells is expressed using Debye expression which occurs as the cells are dispersive at high frequencies. Our model explains the temporal evaluation of electroporation and the acoustic wave produced in the fluid due to the bi-lipid membrane under constant stress which produces electrodeformation. This method can find application in acoustic imaging where the back-projection

method is applied to assess whether the cell has undergone apoptosis or the membrane of the cell has lost its integrity during electroporation.

PO-67

Texture Analysis of H-scan Ultrasound Images for the Characterization of Breast Tumors

Zhanjie Zhang[1], Sio Hang Pun[1], Peng Un Mak[1], Hung Chun Li[2], Kung Jui Hou[2], Mang I. Vai[1]
[1]University of Macau, Macao
[2]Lingyange Semiconductor Inc., China

Texture analysis of breast ultrasound images is widely used in the tissue characterization of breast tumors, as the texture features are closely connected to the scattering patterns and microstructures of the tumors. H-scan imaging is a novel ultrasound imaging method to differentiate the backscattering patterns inside different tissue structures. In this work, the feasibility of H-scan image texture analysis for the characterization of breast tumors is assessed. Five texture features (Contrast, Energy, Entropy, Homogeneity, and Correlation) are obtained from the H-scan images based on the Open Access Series of Breast Ultrasonic Data (OASBUD) involving 100 breast tumors of 78 female patients. Texture analysis results demonstrated significant differences ($p<0.05$) between benign and malignant breast tumors for the selected features derived from H-scan images. Moreover, several textural features (Energy, Entropy, Correlation) from H-scan images began to show significant differences between certain BI-RADS category levels (level 4a with level 5, level 4b with level 5). In contrast, no significant difference was in the features extracted from B-scan images of the aforementioned BI-RADS category groups. Overall, this study demonstrates that texture analysis of H-scan images is helpful for characterizing breast tumors.

PO-69

Prognosis and Uncertainty Management for Filament Degradation of X-ray CT Tubes with IoMT time series data

Jie Zhong, Heng Zhang, Qiang Miao, Qilin Liu, *Jin Huang*
Sichuan University, China

X-ray Computed Tomography (CT) represents a pivotal medical apparatus utilized in hospitals for disease diagnosis and treatment. X-ray tube is a critical component in CT responsible for X-ray generation, with its performance directly affecting imaging resolution and diagnosis accuracy. The tube will gradually deteriorate due to usage, aging, and improper maintenance, which has a negative impact on the performance of CT, and even leads to costly maintenance and casualties. Existing research mostly focuses on optimizing its design to improve the inherent reliability of tube. Prognostic and health management during clinical application are inadequate for bolstering operational reliability and furnishing maintenance guidance to mitigate hospital downtime losses. This research propose a prognosis and uncertainty management framework for filament degradation of X-ray CT tubes with time series data. First, time series data of X-ray tube in clinical application is procured via the Medical Internet of Things (IoMT). Second, a degradation index is constructed based on the filament degradation mechanism. Based on setting parameter fixed and data smoothing techniques, the stable filament degradation data is extracted by mitigating interference from environmental noise and scanning positions. Third, a long-time prediction model based on one-dimensional convolutional neural network is devised to learn the filament degradation process, while the Monte Carlo dropout method is employed to implement uncertainty management throughout the degradation process. Finally, the temporal IoMT data of CT and tubes in West China Hospital, Sichuan University are utilized to demonstrate the effectiveness of the proposed framework. This work aims to fill the gap in operational reliability prognosis of X-ray tube in clinical application. Further, the predictive and uncertainty management results have the potential to be used for predictive maintenance of CT in hospitals, thereby reducing maintenance costs and avoiding safety incidents.

Poster session

Wednesday morning poster session
Jun 12, 10:00 – 10:30

PO-02

BIM operations and clinical engineering in the training of the biomedical engineer

Luis Vilcahuaman
Pontifical Catholic University of Peru, Peru

The use of computer tools for the design and construction of hospitals under the BIM (Building Modeling Information) method allows integrative and collaborative work between different specialists in architecture and engineering. However, after construction, it is necessary to guarantee the operation of the hospital by complying with the aspects of functionality, efficiency, safety and cost control. The traditional approach of the clinical engineer is aimed at addressing biomedical equipment, without emphasizing hospital systems and the environment. Both require integrative and collaborative work, so it is necessary to improve the traditional approach to guarantee the operation of current hospitals. This requires improving the training of the biomedical engineer, and in particular the training of the clinical engineer, who, beyond medical equipment, must contribute to guaranteeing the functionality and safety of the entire technological environment of a clinical service. As a result, it is expected to recover existing hospitals and to better plan the operation phase in a modern hospital.

PO-04

Baroreflex function in young patients with obesity: analysis of the cardiac chronotropic and vascular resistance baroreflex arms

Jana Čerňanová Krohová[1], Barbora Czippelova[1], Zuzana Turianiková[1], Miriam Kuricova[1], Dana Cernochova[1], Luca Faes[2], Michal Javorka[1]

[1]Comenius University and University Hospital, Slovakia

[2]University of Palermo, Italy

Impairment of baroreflex function is one of the factors that could contribute to the development of hypertension, through an imbalance in the sympathetic-vagal outflow to the heart and blood vessels. Obesity significantly increases the risk of arterial hypertension. We assume that the preclinical stage of hypertension development in young patients with obesity could precede arterial hypertension for years. The main objective of this study was to investigate potential changes in baroreflex function as one of the mechanisms potentially contributing to future hypertension development in young normotensive patients with obesity.

Nineteen normotensive adolescents and young adults (O group, 14f, age range: 13.7 – 25.4 years; median age: 16.8 years) and nineteen sex-matched healthy lean participants (C group, 14f, 13.7 – 25.4 years; median age: 16.9 years) were studied. We non-invasively recorded beat-to-beat values of mean blood pressure (MBP) by the photoplethysmographic volume-clamp method (Finometer Pro, FMS, Netherlands), RR intervals by ECG (CardioFax ECG-9620, NihonKohden, Japan), and cardiac output (CO) by impedance cardiography (CardioScreen® 2000, Medis, Germany) during supine rest (15 min) and head-up tilt (HUT, 8 min). Next, beat-to-beat values of peripheral vascular resistance (PVR) were calculated as the ratio of MBP and CO. Spectral coupling (a measure of causal coupling strength in the frequency domain) and spectral gain (baroreflex sensitivity, a measure of the response of the RR and PVR to the unit change in MBP) in the cardiac chronotropic (from MBP to RR) and vascular resistance baroreflex (from MBP to PVR) arms were evaluated using the partial spectral decomposition method in the low frequency band (0.04 – 0.15 Hz).

Significantly lower spectral gain values were observed in the vascular resistance baroreflex arm in the O group during the supine rest phase ($P = 0.014$). During HUT, the spectral gain in both baroreflex arms was significantly lower in the O group ($P \leq 0.002$). No significant differences were observed in the spectral coupling values.

Obesity-related impairment of baroreflex function, affecting both heart rate and vasomotion control, could be one of the factors contributing to the future development of hypertension in this high-risk associated group.

Supported by grant VEGA no. 1/0283/21.

PO-06

Artificial Intelligence Advancements in Fetal Monitoring: Enhancing Prenatal Care

Dragoș-Daniel Țarălungă, Ionut Manea, Rares-Marin Preoteasa, Bogdan Cristian Florea, Georgeta-Mihaela Neagu

National University of Science and Technology Politehnica Bucharest, Romania

Pregnancy and the delivery of a healthy baby rank among the crucial milestones in the human life cycle. Obstetrical science is devoted to ensuring these events unfold as smoothly as possible, promoting the well-being of both the infant and the mother. The primary challenge in achieving this objective is the occurrence of fetal deaths within the uterus, which represents a significant obstacle to the overall goal of a healthy outcome for

the baby and the mother. Fetal monitoring is an essential aspect of prenatal care, aiming to assess the health and well-being of the developing fetus during pregnancy. There are various approaches for fetal monitoring used in clinical practice: cardiotocography (CTG) and Doppler ultrasound, fetal electrocardiography, fetal ecography etc. However there are crucial limitations: inter- and intra-observer variability, invasivity, low signal to noise ratio (SNR) etc. The aim of the present study is to evaluate the current contribution of artificial intelligence (AI) advancements in offering innovative solutions to enhance accuracy, early detection, and overall efficiency in assessing fetal health.

PO-08

Using localized electroporation for transfecting cardiac cells

Jernej Jurič, Vid Jan, Tina Turk, Lea Rems
University of Ljubljana, Slovenia

The permeabilization of the cell membrane and concurrent transfer of chemical or biological agents into cells can be facilitated through diverse methodologies. Among these, electroporation, allowing enhanced delivery of exogenous molecules into the cell interior after exposure to pulsed electric fields, is regarded as a viable alternative to viral, lipid, and other nanoparticle-based delivery systems. Traditionally, bulk electroporation (BEP) has been utilized for most transfections in vitro. In BEP, cells are placed between two electrodes and subjected to an approximately homogeneous electric field. The disadvantage of BEP is that it increases membrane permeability over a large membrane surface area and is thus associated with quite high cellular damage. By localizing the electric field over a small membrane area using a nanoporous substrate, it is possible to improve transfer efficiency while providing greater cell survival and better control over gene expression. In this study, we investigated the potential of localized electroporation for transfecting rat cardiac cell line H9c2 and isolated rat ventricular cardiomyocytes, by using polyethylene terephthalate (PET) membranes with 0.4 μm pore diameter, which are commercially available in the form of cell culture inserts. We identified appropriate process parameters and successfully electroporated the cells, employing either propidium iodide or a plasmid encoding the green fluorescent protein as validation markers.

PO-10

The Study of Non-Invasive Blood Information Measurement and Monitoring Method via Wearable AWPPG Device

Chung ChiFu[1], Lu PoWen[2], Cheng Chun Chang[1]
[1]National Taipei University of Technology, Taiwan
[2]Taipei Medical University, Taiwan

In recent years, with the proliferation of wearable devices, wearable watches and wristbands capable of measuring physiological information have become indispensable tools for many in modern society. These wearable devices allow individuals to monitor real-time physiological data, such as heart rate, blood pressure, and blood oxygen concentration, to maintain their health. However, there is currently no non-invasive method available on the market for measuring blood-related information within the human body.
Therefore, this study aims to investigate whether wearable devices can provide a non-invasive means of acquiring blood-related information through related signal processing algorithms and neural network models, utilizing an All-Wavelength Photoplethysmography (AWPPG) approach combined with neural network models for accurate measurement of blood information. The research is divided into three main components: the development of a non-invasive wearable device, the collection of blood information in a clinical setting, and the exploration of one-dimensional signal algorithm models.
Currently, we have collected blood-related data at the hospital using our self-developed AWPPG measurement device. We have also trained artificial intelligence models for various blood parameters. The accuracy rate for blood glucose is seventy percent, while for hemoglobin, platelet count, sodium ion concentration, calcium ion concentration, and total protein content, the accuracy rate is approximately sixty to seventy percent.

PO-12

Development of Neurorehabilitation Bicycle with Posture Control Detection

Ya-Ju Chang[1], Hsiao-Lung Chan[1], Jr-kai Yu[1], Miao-Ju Hsu[2], Rou-Shayn Chen[1]
[1]Chang Gung Memorial Hospital and University, Taiwan
[2]Kaohsiung Medical University, Taiwan

Patients with central nervous system injur-

ies such as stroke, spinal cord injury, Parkinson's disease, etc., often suffer from impaired motor functions, affecting their quality of life. Among these impairments, balance and gait disturbances are crucial rehabilitation issues, and adjustments in posture balance are necessary during walking to prevent falls and improve walking efficiency. In neurorehabilitation, bicycle training is believed to establish a central pattern generator (CPG) for controlling walking and is commonly used. However, traditional neurorehabilitation bicycles lack simutaneous posture balance control training or detection, potentially reducing the translation of training effects into walking ability. Therefore, the purpose of this study is to develop a rehabilitation bicycle with posture and balance detection and training functions and to conduct a human study.
In the first part of the research, we developed a saddle force plate for bicycle use, utilizing three transducers to replace the traditional four transducers, calculating the COP (Center of Pressure) data of the saddle. In the second part of the research, we recruited 30 subjects to study the correlation between COP displacement and trunk inclination angle during non-riding and riding conditions.
The research findings revealed that both static and riding states showed a significant correlation between COP displacement area and body inclination angle, but a high linear correlation was observed only in static conditions. Additionally, during riding, the COP displacement area varied significantly with different inclination angles and riding speeds.
The results of this study confirm the feasibility of simultaneously detecting and training body posture control during cycling, although the actual body inclination angle requires additional calibration. The equipment and training modes developed in this study could be applied to the rehabilitation of patients with neurological disorders in the future.

PO-14

Mapping side effects for deep brain stimulation in essential tremor

Teresa Nordin[1], Erik Österlund[2], Dorian Vogel[3], Anders Fytagoridis[2], Simone Hemm[3], Karin Wårdell[1]
[1]Linköping University, Sweden
[2]Karolinska Institute, Sweden
[3]University of Applied Sciences and Arts Northwestern Switzerland, Switzerland

Introduction: Deep brain stimulation (DBS) is an established therapy for Essential tremor (ET) with the ventral intermediate nucleus of the thalamus (Vim) and the zona incerta (Zi) are common targets. Implantation in these structures usually results in a reduction of tremor, providing efficient therapy while avoiding side effects is a larger challenge. This work aims at creating and validating a method for mapping side effects in Zi-DBS for ET.
Methods: Stimulation parameters and pre- and postoperative imaging from 71 ET patients were included in this study. The amplitude and contact that generated side effects were retrieved during a monopolar screening where the effect was evaluated in each contact on a quadripolar lead with increasing amplitude in steps of 0.2-0.3 V up to 5V. Based on the registered side effects, 8 groups were identified (speech affection, visual affection, dizziness, paresthesia (all), paresthesia arm/hand, ataxia arm, muscular contraction, sweating) for further analysis. For each stimulation setting, the electric field around the lead was simulated (n=852) with the finite element method and transformed to an MRI template normalized from the same cohort. A probabilistic map (PSM) was computed for each side-effect based on a voxel-wise Wilcoxon signed rank test, with a permutation test for correction of family-wise error. To validate the maps, a support vector machine (SVM) classification model was created based on four predictors extracted from the overlap between the PSM and the electric field. The validation was performed in a leave-one-out fashion, where the PSM and SVM were computed with all but one patient and evaluated using the left-out patient. The process was repeated until all patients had been left out.
Result: PSMs were computed for all side effects, but sweating did not result in any cluster surviving the analysis. Generally, a trend of lower p-values for side effect PSMs with higher occurrence, up to side effects occurring in around 100 stimulations. This trend was also seen in the validation, where accuracy and true positive rate increased with increasing sample size. The true negative rate was higher than the true positive rate for all side effects except paresthesia.
Conclusion: A workflow for predicting side effect occurrence in deep brain stimulation was developed. For a stable result, the number of included simulations is important and should be systematically investigated in the future. Future studies will be conducted to combine

improvement and side effects to predict the optimal DBS setting for a wide therapeutic window.

PO-16

Exploring the impact of data and statistical methods for defining sweet spots in Deep Brain Stimulation

Vittoria Bucciarelli[1], Dorian Vogel[1], Teresa Nordin[2], Karin Wårdell[2], Jérôme Coste[3], Jean-Jacques Lemaire[3], Raphael Guzman[4], Simone Hemm[1]

[1]FHNW University of Applied Sciences and Arts Northwestern Switzerland, Switzerland

[2]Linköping University, Sweden

[3]Université Clermont Auvergne, France

[4]University Hospital Basel, Switzerland

The precise location of the sweet spot (optimal target), for Deep Brain Stimulation (DBS) is still under investigation. Nevertheless, its identification holds significant importance in guiding algorithms for the automatic programming of DBS parameters. Previous studies have predominantly used t-tests and Wilcoxon tests to generate probabilistic stimulation maps. A comprehensive evaluation of both the dataset and the chosen statistical method's impact on the extracted sweet spot from group analysis is lacking. This study aims to compare the outcomes of these statistical tests applied to two DBS datasets with distinct compositions.

The data used in this study was obtained from intra-operative stimulation tests on 6 Essential Tremor (ET) patients with implants in the ventral-intermediate nucleus (VIM). Stimulation parameters were used to generate patient-specific electric field simulations, subsequently transformed to a group-specific MRI template. Voxel-wise one-tailed one-sample t-tests and Wilcoxon signed-rank tests were performed to identify voxels significantly associated with tremor improvement exceeding 60% ($p < 0.05$). False Discovery Rate (FDR) correction was applied to mitigate false positives. The significant clusters obtained with the two methods were compared visually and by calculating their total volume, intersection volume, and Dice coefficient. Additionally, validation was conducted by correlating the overlap between the electric field and sweet spot with the improvement observed in the clinic. The same tests were then repeated on a subset of the data, including only the 50 best configurations per patient weighted by amplitude.

The statistical analyses on the complete dataset revealed sweet spots of varying sizes: 28.88 mm3 for the t-test and 58.25 mm3 for the Wilcoxon test. The Dice coefficient between the two was 66%. The significant volume obtained with the t-test was entirely enclosed in the volume extracted with the Wilcoxon test. For the best configurations sweet spot volumes were 567.63 mm3 for t-test and 560.88 mm3 for Wilcoxon, with a Dice coefficient of 99.3%. Stimulations activating the sweet spot were correlated to improvement with similar coefficients between methods but higher when using sweet spots derived from the complete dataset.

Users should be conscious of the strong influence that the dataset and chosen statistical method exert on the extracted sweet spot in group analysis. Restricting analysis to optimal parameters leads to inflated volumes undermining the ability to identify high improvement areas. Despite the difference in extracted volumes between the methods, both provided a significant correlation with clinical improvement. Thus, further criteria to inform the method's selection are needed.

PO-18

REDCap and SQLite: a powerful combination for streamlining metadata capture in Deep Brain Stimulation research

Marc Stawiski[1], *Vittoria Bucciarelli*[1], Dorian Vogel[1], Jérôme Coste[2], Jean-Jacques Lemaire[2], Siegward Elsas[3], Ute Gschwandtner[4], Peter Fuhr[4], Ethan Taub[4], Simone Hemm[1]

[1]FHNW University of Applied Sciences and Arts Northwestern Switzerland, Switzerland

[2]Université Clermont Auvergne, France

[3]Arlesheim Hospital, Switzerland

[4]University Hospital Basel, Switzerland

The field of Neurosciences research faces significant challenges in managing heterogeneous data types. While the Brain Imaging Data Structure (BIDS) offers a standardized format for brain imaging data organization, its limitations in capturing detailed clinical metadata, such as longitudinal clinical scores or demographic information become apparent in data analysis pipelines. To address this critical limitation, this work proposes a framework for enhanced metadata capture based on the example of Deep Brain Stimulation (DBS). It leverages BIDS with Research Electronic Data Capture (REDCap), a secure web-based platform designed for validated data collection, and SQLite, a lightweight re-

lational database management system capable of storing structured metadata. BIDS offers organization of data in neuroscience research, and RedCap user-friendly clinical data entry for clinicians.
Patient-related metadata (e.g. demographics, medication, neurological assessments) is collected via structured forms within REDCap. Medical image data, originating from Brainlab Elements neurosurgical planning station, is stored and transferred in the anonymized DICOMDIR format. To ensure BIDS compliance, a custom Python script extracts relevant information from the DICOMDIR data. This extracted data is converted into the Neuroimaging Informatics Technology Initiative (NIfTI) format, and the resulting files are stored in a BIDS-compliant directory structure. Additionally, image references are established within the SQLite database, which also serves as repository for metadata extracted from REDCap.
To validate the proposed framework, data was collected and analyzed from two medical institutions: the University Hospitals Basel and Clermont-Ferrand. Our framework has successfully captured data for 107 patients, with an average of 35 imaging files including MRI and CT scans and labeled anatomical structures. This data is stored and managed within the patient-centric SQLite database. The database schema comprises 28 tables, 230 data fields (e.g. patient ID, age, implanted position, image file path) and 33 established relationships between these tables. The advantages of using such a system can be particularly appreciated in the use-case of group-level analysis. The system design facilitates efficient retrieval of structured clinical data. Furthermore, the framework effectively handles and stores files generated during post-processing steps, ensuring data integrity and traceability. This work demonstrates the successful integration of a translational tool for streamlining data collection and organization between clinics and research institutes. Our framework captures both standardized imaging data and comprehensive patient-metadata within a unified system. This enables researchers not only in the field of DBS but from the Neurosciences in general to leverage the richness of both types of data, potentially leading to improved clinical decision-making and ultimately, better patient outcomes.

PO-20

Numerical Study of Hemodynamic Characteristics on the Surgery of Pulmonary Artery Banding

Jinlong Liu[1], Weiru Luo[2], Jiwen Xiong[1], Yanjun Sun[1]
[1]Shanghai Jiao Tong University, China
[2]Waseda University, Japan

Pulmonary artery banding (PAB) is a commonly used procedure for the restriction of pulmonary blood flow by surgically creating a stenosis in the main pulmonary artery (MPA). Two types of PAB are available in clinic. One is called the extraluminal pulmonary artery banding (E-PAB), reducing the lumen of the MPA by placing a band outside the MPA. The other is the intraluminal pulmonary artery banding (I-PAB) with suturing a perforated patch on the inner wall of the MPA to restrict the pulmonary flow. There is still controversy over which surgical method to choose. Here, we reported our numerical studies on the hemodynamic characteristics of different PAB methods based on a three-dimensional model of pulmonary artery, thus to help surgical planning. The model of pulmonary artery was reconstructed according to patient-specific computed tomography images. Computer-aided design (CAD) was used to perform virtual surgeries of E-PAB and I-PAB, respectively. Pulsatile simulations and hemodynamic analysis were conducted to capture the differences of postoperative hemodynamics using the method of computational fluid dynamics (CFD). The local hemodynamic features in E-PAB and I-PAB models were illustrated with the pressure drop, velocity streamlines, wall shear stress (WSS) and energy loss (EL). The results showed the flow field closed to the banding site in the I-PAB model was presented with more flow turbulence due to the block of the patch. The pressure drop and WSS between the upstream and downstream of the banding site were higher in the I-PAB model, compared to that of E-PAB model. The EL of I-PAB model was more than that of E-PAB model. The study indicated that the E-PAB was associated with better hemodynamic performance in controlling pulmonary artery pressure and reducing the cardiac burden. The numerical simulation of CFD combined with CAD is an effective approach for the investigation of preoperative surgical planning and postoperative hemodynamic prediction.

PO-22

Monte Carlo Simulated Photoplethysmography Signals for the Validation of an In Vitro Wrist Phantom

Raghda Al-Halawani, Meha Qassem, James May, Panicos A. Kyriacou

City, University of London, United Kingdom

Photoplethysmography (PPG) is an optical technique used for the continuous monitoring of blood volume changes, and is integrated in a variety of medical devices and consumer wearables. Meanwhile, in silico and in vitro experiments have shown to facilitate our understanding of light-tissue interactions to assess the feasibility and accuracy of PPG-based technologies in acquiring PPG signals from the human anatomy. Therefore, this study demonstrates an approach to validate an in vitro study of a developed wrist phantom through a Monte Carlo (MC) simulation to compare PPG signals generated from experimental and computational models. The MC model simulates a PPG signal using MATLAB, and accounts for the optical and mechanical properties of the phantom and vessel in synchrony with changes in internal blood pressure. Key features of the PPG signal, such as onsets, and systolic and diastolic slopes are visually apparent. Additionally, the use of in-built MATLAB functions is recommended to improve the morphology of the PPG signal to optimise computational resources. Overall, the current study shows the applicability and potential of Monte Carlo simulations to validate PPG data acquired from in vitro models.

PO-24

Identification of Barriers in the Adoption and Promotion of Advanced Endoscopic Systems and Minimally Invasive Surgical Equipment in China: Evidence from a Survey of 320 Healthcare Facilities

Zhichen Wang, Fei Sun, Qian Zhang, Jing Sun, *Jingyi Feng*

Department of Clinical Engineering and Material Supplies, the First Affiliated Hospital of Zhejiang University, China

Objective: To thoroughly understand the current status of high-end endoscopic systems and minimally invasive surgical equipment configurations in medical institutions across China's six major regions, as well as the situation regarding endoscopy-related education and training. This aims to provide a data foundation for constructing an application demonstration system and clinical evaluation system suitable for different centers and domestic advanced minimally invasive surgical instruments. Methods: To construct the survey questionnaires, a robust methodological approach was employed, combining expert consultations, the Delphi method, and an extensive review of existing literature to ensure the inclusion of relevant and comprehensive content. These questionnaires were then electronically distributed to various levels of medical institutions across the nation, leveraging the expertise of specialists from multiple disciplines. The responses collected were subjected to rigorous statistical analysis to extract meaningful insights. This systematic approach facilitated a detailed evaluation of the current state of high-end minimally invasive surgical instruments in these institutions, focusing on the availability, deployment, and training capabilities associated with advanced medical equipment. Results: The configuration of high-end endoscopic systems and minimally invasive surgical instruments in medical institutions at all levels is generally low, with significant room for increase in the proportion of domestically produced equipment. Furthermore, the frequency and capability of training related to endoscopic systems are also slightly lacking. Conclusion: Equipment and training are crucial foundations for the promotion of advanced minimally invasive surgery, largely determining whether medical institutions are capable of performing high-end minimally invasive operations. Currently, there are issues with insufficient configurations of high-end endoscopic systems and minimally invasive surgical instruments, inadequate training, and a low proportion of domestically produced equipment. There is an urgent need for homogeneous and standardized research and application of domestic advanced minimally invasive surgical instruments and techniques nationwide to effectively address these existing problems.

PO-26

Co-transfection of anti-fibrotic microRNAs as a treatment for oral submucous fibrosis

Kai-Chiang Yang[1], Chih-Yuan Fang[1], Hsing-Yu Chen[2], Yung-Hsin Cheng[2]

[1]Taipei Medical University, Taiwan

[2]National Taiwan University of Science and Technology, Taiwan

Oral submucous fibrosis (OSF) is a disease characterized by excessive extracellular mat-

rixes (ECM) deposition (especially collagen) and is highly associated with the areca quid chewing habit of patients. Arecoline, a natural alkaloid of the betel nut, may activate the transforming growth factor-beta (TGF-β) signaling pathway and subsequently switch on downstream genes related to fibrosis and ECM production. TGF-β/Smads cascade is known as the major inducer of myofibroblast differentiation in OSF. Several studies have found that the dysregulation of microRNA (miR) is involved in the progression of various fibrotic diseases. Therefore, we surveyed 16 fibrotic-related miRs and proposed delivering exogenous miR mimic or inhibit simultaneously as a treatment for OSF. Human oral submucosal fibroblasts were subjected to varying concentrations of arecoline (5, 10, 20, 40, or 100 μg/mL) for either 24 or 48 hr, and cell viability, death, mRNA expression of TGF-β and alpha-smooth muscle actin (α-SMA), and protein production of STRO-1, type I collagen, vimentin, and α-SMA were evaluated by Western blot. Subsequently, based on the results of these analyses, the condition involving 20 μg/mL of arecoline and 24 hr of exposure was selected. The stimulated OSF fibroblasts were transfected with 16 miRs individually by using cationic lipid transfection reagents. Based on the ability to downregulate TGF-β and α-SMA mRNA expressions, miR-29a mimic, miR-150 inhibitor, miR-196a mimic, and miR-509-5p mimic were further selected. Co-transfection of the above 4 miRs further downregulated the mRNA levels of COL1A1 and matrix metalloproteinase-7 in myofibroblasts. Furthermore, transfected cells' wound closure, cell migration, and collagen gel contraction abilities were inhibited. In conclusion, co-transfection of anti-fibrotic miRs can be a treatment for OSF.

PO-28

Analysis of Open-Source Softwares for Ultrasound Tomography Based on Full-Waveform Inversion

Lucas da Costa, Nilton Assugeni Neto, João Henrique Uliana, Théo Pavan, ***Antonio Adilton Carneiro***

Department of Physics – Faculty of Philosophy, Sciences and Letters at Ribeirão Preto, University of São Paulo, Brazil

Breast cancer is the second-leading cause of cancer-related deaths in women (Siegel et al,. 2024). The gold standard for diagnosing breast cancer is mammography, an uncomfortable exam that uses ionizing radiation. Ultrasound is used as an auxiliary exam for diagnosis, but studies show the potential of Ultrasound Transmission Tomography (UTT) to replace mammography. UTT began in the 1970's with pioneering studies by Greenleaf et al. and Carson et al., imaging the speed of sound and attenuation coefficient. Nowadays there are numerous methods of tomography acquisition, two of these methods can be categorized into linear-array transducers and ring-array transducers. Our objective is to compare simulation and reconstruction systems to determine the most efficient reconstruction method. Full-Waveform Inversion (FWI) is a seismic technique renowned for its high resolution and adaptability to ultrasound tomography applications. In our study, we integrated open-source implementations for linear arrays developed by Rehman Ali (2022) and utilized the ring array provided by the Stride framework (Cueto et al,. 2022) for comparative analysis, both use FWI as reconstruction method.The phantom utilized was adapted and modified from a cone-beam breast CT image (J. Uhlig et al., 2017; Rehman Ali, 2022). For the linear array, we utilized k-wave to simulate a pair of transducers with 192 elements, at a central frequency of 1 MHz, 0.6 mm pitch, and a spatial grid with 0.6 mm. For the ring array, we used the toolkit offered by Stride to simulate 128 elements, with a central frequency of 1 MHz, and a spatial grid of 0.5mm. Our simulations using both tools revealed that the linear transducer yielded a mean error in speed of sound of 1.98 m/s, with a standard deviation of 2.98 m/s. For the ring array, we obtained a mean error of 10.1 m/s and a deviation of 6.8 m/s. In the analysis, the linear transducer demonstrated a better estimation. To determine the best methodology, we need to observe the differences between frameworks; for example, the differences in the simulation algorithm can create discrepancies. Our next step is to eliminate these differences to have a better understanding of the requirements necessary to achieve a quality parameter for linear and ring arrays.

PO-30

Improving diagnostic performance of an automated melanoma diagnostic system using fast style transfer data augmentation

Takashi Nagaoka, Mitsutaka Nemoto, Yuichi Kimura

Kindai University, Japan

Melanoma is a highly malignant skin tumor that is difficult to distinguish from benign lesions. Quantitative methods are required to support early detection of melanoma, and AI-based melanoma diagnosis system is becoming increasingly popular. Deep learning requires a large number of images for training, but it is difficult to obtain a large amount of medical information such as dermoscopic images, and some form of data augmentation is needed. In this study, we used fast style transfer (FST), as a data augmentation method and verified the change in diagnostic accuracy. In this study, 1000 melanoma and non-melanoma cases are randomly selected from a dataset called HAM10000 ("Human Against Machine with 10000 training images"). Using the dataset, 999 fake images are generated from a single image using the FST in advance. The melanoma discrimination model is built using automated machine learning. AutoKeras 1.1.0 is used to build an EfficientNet-based deep learning model. The model initially used common augmentation methods such as rotation and flipping. During training, our model randomly replaces some of the images with fake images pre-generated by the FST. Diagnostic accuracy is calculated using a 5-fold cross-validation. The diagnostic accuracy of our model with and without augmentation by the FST was 83.0+2.0% and 81.1+2.2%, respectively.

PO-32

Estimating stride length through a deep learning model utilizing foot inertial data in individuals with Parkinson's disease

Hsiao-Lung Chan, Ya-Ju Chang, Ai-Tung Hsieh, Rou-Shayn Chen

Chang Gung Memorial Hospital and Chang Gung University, Taiwan

Gait disorders present a significant challenge in Parkinson's disease, often manifesting as a reduction in stride length, particularly in off-medication situations. Utilizing an inertial measurement unit on the lower extremity provides a convenient method for measuring stride length, irrespective of space constraints. While recent advancements in deep learning have proven effective in estimating stride length from the inertial data, these models predominantly rely on data from healthy subjects, with limited representation from individuals with gait disorders. In this study, we developed a deep learning model to predict stride length by leveraging tri-axial accelerations and tri-axial angular velocities gathered from the lateral side of shoes. Our proposed model incorporates a U-Net architecture designed for extracting crucial features, which was trained using randomly selected 1-second data segments from 10 individuals with Parkinson's disease. Subsequently, the U-Net's encoder path outputs serve as features for predicting stride length through a multilayer regression model. Utilizing leave-one-out cross-validation between the predicted stride length and the ground truth acquired from the GAITRite electronic walkway, a remarkable R-squared correlation of 0.88 and an error percentage of 8.385% were achieved when employing the 1-second segments preceding toe-off. We conducted additional tests to assess the impact of inaccurate detection of the toe-off event. This was simulated by randomly shifting time offsets ranging from 0.05, 0.1, 0.2, to 0.5 seconds in both negative and positive directions. It's worth noting that the evaluation specifically focused on the 0.5-second offset shifting, eliminating the necessity for stride identification. These configurations yielded R-squared correlations of 0.898, 0.876, 0.87, and 0.81, along with error percentages of 7.96%, 8.63%, 8.74%, and 10.80%, respectively. For future work, recruiting a larger number of individuals with PD would be beneficial to encompass a broader spectrum of gait variations within the PD population.

PO-34

A Convolutional Neural Network (CNN) based Electrocardiogram (ECG) Pattern Analysis under Cycling Movement with the Applications into the Development of an Exhaustion Stratification System

Szi-Wen Chen[1], Yu-Hsuan Huang[1], Rou-Shayn Chen[2]

[1]Chang Gung University, Taiwan

[2]Chang Gung Memorial Hospital, Taiwan

This research introduces a new approach utilizing electrocardiogram (ECG) data and deep learning techniques to effectively stratify and quantify exercise-induced fatigue using a novel indicator, dubbed the exhaustive status index (ESI). The study synchronizes ECG recordings with cycling movements, facilitating real-time monitoring of physiological responses during exercise. To capture nuanced patterns indicative of fatigue, ECG signals are meticulously segmented into short segments,

optimizing data granularity. These segmented ECG signals serve as two-dimensional (2D) inputs to a convolutional neural network (CNN), a powerful tool for extracting complex features and patterns from input data. Leveraging the CNN architecture, the study calculates the ESI, a metric designed to reflect the subject's exhaustive status accurately. By analyzing ECG patterns captured during exercise, the ESI provides valuable insights into the individual's physiological response to exertion. During the experimental protocol, exercise cessation criteria are standardized, with termination triggered when the Borg scale value reaches 20, maintaining constant resistance and a cycling cadence of 60 revolutions per minute (RPM). This stringent control ensures consistency across participants and facilitates accurate assessment of fatigue levels. Signal segmentation methodology adopts a blind approach, dividing ECG signals into 2-second segments with a 50% overlap. This segmentation strategy optimizes data utilization while preserving temporal information critical for fatigue classification. In order for training process, the training dataset is divided into two distinct categories: less-exhaustive and near-exhaustive, comprising ECG signals recorded from the vicinity of two extremes of fatigue status. For each subject, each category comprises 40 ECG signals utilized for model training, ensuring robustness and generalizability of the developed classification system. To evaluate model performance, our study employs well established deep learning architectures, including GoogleNet, ResNet-18, and ResNet-50. Numerical results showcase the efficacy of these CNN models in accurately stratifying exhaustive status, highlighting their potential as valuable tools for fatigue assessment in exercise physiology research. Furthermore, regression analysis examines the relationship between the calculated ESI and subjective Borg scale values, revealing a positive correlation. This finding underscores the utility of the ESI as a reliable indicator of exercise-induced fatigue, complementing subjective perception metrics with objective physiological assessments. Overall, this study contributes to advancing our understanding of fatigue dynamics during exercise and exploits the potential of ECG-based deep learning approaches in enhancing performance monitoring and athlete management strategies.

PO-36

The Prediction of Sleep Quality using Heart Rate Varia-bility Modulations during Wakefulness

Andrea Di Credico, ***David Perpetuini***, Pascal Izzicupo, Giulia Gaggi, Nicola Mammarella, Alberto Di Domenico, Rocco Palumbo, Pasquale La Malva, Daniela Cardone, Arcangelo Merla, Barbara Ghinassi, Angela Di Baldassarre

University "G. d'Annunzio" of Chieti-Pescara, Italy

Sleep quality is a vital component of one's overall health and well-being. In-adequate sleep quality is linked to various adverse consequences, including cognitive decline, mood disruptions, and an elevated susceptibility to non-communicable diseases. Hence, it is crucial to precisely evaluate the quality of sleep, in order to identify individuals who are at risk and to develop suc-cessful interventions. Importantly, it has been shown that sleep quality can impact physiological processes even when a person is awake, leading to changes in heart rate variability (HRV). From this standpoint, the utilization of wearables and contactless technologies that can measure HRV without causing any discomfort is extremely well-suited for evaluating sleep quality. Nevertheless, there is a dearth of studies that analyze the correlation between HRV and sleep quality during waking. The aim of this study is to create a machine-(ML) learning model that uses HRV data to estimate sleep quality, as evaluated by the Pittsburgh Sleep Quality Index (PSQI). The measurement of HRV was conducted using a wearable photoplethysmography (PPG) sensor positioned on the fingertip. Subsequently, models were created to classi-fy sleep quality based on the PSQI score. By employing the current ap-proach, a classification good accuracy of 76.7% was achieved. In summary, this study has the potential to facilitate the use of wearable and contactless technology for monitoring sleep quality in ergonomic applications.

PO-38

Comparative Analysis of Depression Detection using EEG Signals

Stefana Duta, ***Georgeta-Mihaela Neagu***, Alina-Elena Sultana

National University of Science and Technology Politehnica Bucharest, Romania

This paper presents a comprehensive analysis of Multilayer Perceptron (MLP) models for the classification of EEG signals in the context of depression state detection. Exper-

iments were conducted using two separate databases: the De-pression Rest Database and the MDD vs. Control Database. For the Depression Rest Database, the MLP model reached an accuracy of 84.65% on the training set but faced challenges with validation, plat-eauing at 68.79%. Conversely, the MLP model excelled in the MDD vs. Control Database, achieving an accuracy of 89.99% on the train-ing data and 88.97% on the validation data. It displayed high precision and recall values for both healthy and depressed classes, indic-ating a balanced performance. Additionally, feature selection was explored on a combined database, yielding promising results but with room for further optimizations. The novelty of this study lies in its investigation into whether the com-bination of two datasets, both ori-ented toward the common objective of de-pression, demonstrates superior performance compared to the individual analyses conduc-ted on each dataset.

PO-40

Unveiling Age-Related Patterns in Vocal Ex-pression of Emotions: A Machine Learning Approach with Mel and Gammatone Fre-quency Cepstral Coefficients

Michele Giuseppe Di Cesare, David Perpetuini, Daniela Cardone, Arcangelo Merla
University D. D'Annunzio of Chieti-Pescara, Depart-ment of Engineering and Geology, Italy

The significance of emotional assessment has gained increasing recognition across di-verse fields, such as psychology, healthcare, education, and social sciences. It is deemed crucial for comprehending and addressing a broad spectrum of outcomes, including mental health, academic performance, pa-tient experiences, and social acceptance. A noteworthy aspect of human emotions lies in their expression through a diverse range of vocal sounds, which can be interpreted and understood by the listener. From this perspec-tive, the application of Mel Fre-quency Cepstral Coefficients (MFCCs) and Gammatone Frequency Cepstral Coefficients (GTCCs) emerges as a brilliant approach to portraying the concealed vocal components that express emo-tional states. In this study, we employed Machine Learning (ML) tech-niques to leverage MFCCs and GTCCs, aiming to construct a classifier capable of assessing different emotions. We utilized the freely avail-able Toronto Emo-tional Speech Set (TESS), a dataset comprising vocal recordings of two ac-tresses repeating 200 words in seven dis-tinct emotions. Furthermore, we in-troduced an age-related analysis to gain insights into how age might impact the human capacity to express emotions through vocal expression. Results obtained showed an accuracy of 99.6% in the emotional assessment for vo-cal re-cordings of both actresses employing GTCCs. The age-related studies presented a 100?cur-acy in the emotional assessment restricted to the vo-cal samples from the younger actress, compared to the 98.6% obtained in the one restricted to the older actress. These findings suggest that the age could influence the emo-tional expression.

PO-42

A Machine Learning Framework for Gait and EMG Analysis for Post-Stroke Motor Dys-functions Assessment

Francesco Romano, David Perpetuini, Daniela Cardone, Arcangelo Merla
University D. D'Annunzio of Chieti-Pescara, Italy

A stroke is a notable medical disorder char-acterized by the abrupt cessation of blood cir-culation to the brain, causing a deficiency of oxygen and nutri-ents to brain tissue, which leads to cellular damage or demise. The ef-fects of stroke on individuals may range sig-nificantly, from modest impairments to pro-found disability. Stroke treatment entails ex-tended therapy, often empha-sizing gait re-habilitation. Gait rehabilitation programs fo-cus on enhancing gait symmetry, velocity, and independence, since these qualities have a substan-tial impact on the likelihood of pa-tients reintegrating into their pre-existing sur-roundings. Significantly, the assessment of muscle activation patterns and neuromus-cular control using Electromyography (EMG) measurement during walking is of utmost im-portance for stroke patients. Machine learning meth-ods have the capacity to provide useful insights on the patterns of walking and muscle activation, functional results, and strategies for rehabilitating stroke patients. The object-ive of this research is to use a Support Vec-tor Ma-chine classifier to categorize individu-als with Stroke from healthy controls by ana-lyzing gait and EMG measures, both alone and in combination. The best performances were obtained employing both gait and EMG fea-tures, reaching a test accuracy of 91.4%. The findings can foster the employment of ML ap-proaches to help clinicians to diagnose the stroke severity.

PO-44

Comet Assay in the Digital Era: A Review of the use of Artificial Intelligence for the Analysis of DNA damage based on the results of the Comet Assay

Adna Softić[1], Nejra Merdović[1], Velid Dlakić[1], Emina Mrđanović[1], Lejla Mahmutović[2], Daria Ler[3], Lejla Gurbeta Pokvić[1]

[1]Verlab Research Institute for biomedical engineering, medical devices and artificial intelligence, Bosnia and Herzegovina

[2]International University of Sarajevo, Bosnia and Herzegovina

[3]ASA Institute, Bosnia and Herzegovina

The rapid advancement of genetic testing techniques has revolutionized our understanding of organism health and opened the way for personalized approaches to care and prevention. In light of this progress, this review article explores the intersection of genetic testing, particularly through the Comet assay, and artificial intelligence (AI) methodologies for analyzing DNA damage and predicting organismal health status. Focusing on research published within the last five years, this paper synthesizes the current landscape of studies leveraging Comet assay and AI, with specific attention to artificial neural networks (ANN), convolutional neural networks (CNN), Fuzzy Inference System CNN (FIS CNN), Faster Region based CNN (Faster R-CNN), and Mask Region based CNN (Mask R-CNN). Through a comprehensive examination of recent literature, this review elucidates the potential of integrating advanced genetic testing and AI techniques to enhance our understanding of DNA damage and its implications for organism health, thus opening the way for more precise and personalized approaches to healthcare and disease prevention.

PO-46

Advancing Pediatric Cardiology Training with a VR-Based TEE and Amplatzer Deployment Simulator

David Buyck[1], Enrique Vergara-Escudero[1], Susana Arango[2], Varun Aggarwal[1], Benjamin Gorbaty[1], Paul A. Iaizzo[1]

[1]University of Minnesota, United States

[2]Harvard University, United States

In the specialized field of pediatric cardiology, the imperative to train anesthesiologists in the proficient execution of transesophageal echocardiography (TEE) during the closure of atrial septal defects (ASD) introduces a complex set of educational challenges. Addressing these needs, this paper presents the development and implementation of an innovative virtual reality (VR) simulator designed to enhance the competency of anesthesiologists in performing TEE within the specific procedural context of Amplatzer device deployment for ASD closure. This advanced simulator leverages high-resolution three-dimensional models, meticulously crafted from de-identified contrast-enhanced computed tomography (CT) and micro-computed tomography (CT) scans, to forge a highly realistic and interactive training milieu.

The TEE simulation module, endowed with authentic TEE controls, provides a one-to-one correspondence in terms of realism and interactivity, aiming to markedly elevate the anesthesiologists' proficiency in the navigation and interpretation of echocardiographic images throughout the surgical procedure. While the simulator automates the Amplatzer device deployment phase to concentrate the learning experience on mastering TEE skills, it also imparts an indispensable comprehension of the device deployment process, thereby rounding out the educational experience. Integrating an interactive TEE simulation with an automated process for the deployment of the Amplatzer device, the simulator allows for the continuous imaging of the catheter and device via echocardiography, offering a comprehensive procedural visualization. This educational innovation represents a significant leap forward in the domain of anesthesiology training, offering a cost-efficient, accessible solution that necessitates nothing more than a VR headset and a computer of adequate capacity. The introduction of this simulator into the training regimen of anesthesiologists is anticipated to substantially improve the understanding, execution, and efficiency of TEE-guided procedures, which are critical for the successful closure of ASDs. Preliminary feedback from the use of this simulator has been overwhelmingly positive, highlighting its efficacy in enhancing essential procedural skills among anesthesiologists. Future research endeavors will aim to provide a quantitative assessment of the simulator's impact on educational outcomes and explore its potential integration into broader training curricula. Such research will pave the way for improved procedural success rates and patient outcomes in the field of pediatric cardiology, thereby underscoring the significant role of innovative

educational tools in advancing medical practice and patient care.

PO-48

Automatic Prediction of Pediatric Postoperative Behavioral Disturbance from Neuronal Activity During Anesthesia

Javier Gomez-Pilar[1], Laura Gutiérrez-de Pablo[2], Carlota Gordaliza[3], Estefanía Gómez-Pesquera[3], Jesús Poza[1], Eduardo Tamayo[4], Roberto Hornero[1]

[1]Universidad de Valladolid and Centro de Investigación Biomédica en Red en Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN), Spain

[2]Bioengineering Department, University Carlos III of Madrid, Spain

[3]Faculty of Medicine, University of Valladolid, Spain

[4]Biomedical Research Networking Center in Infectious Diseases (CIBERINFEC), Carlos III Institute of Health, Spain

The process of undergoing general anesthesia can be distressing for children and has the potential to induce adverse behavioral changes. This alteration, named Postoperative Behavioral Disturbance (PBD), manifests not only during the induction of anesthesia but also upon awakening from it, as well as after discharge home. While previous studies have predominantly assessed behavioral dynamics during anesthesia induction and emergence stages, post-hospitalization alterations remain underexplored. Using electroencephalographic (EEG) recordings obtained during a surgery procedure to monitor neural activity involving anesthesia induction, we hypothesize the feasibility of predicting children who are at a higher risk of experiencing PBD. Therefore, this study aims to develop an automatic predictive model for identifying pediatric patients who will experience PBD, based on EEG, clinical, and sociodemographic variables, enabling personalized treatment and minimizing adverse consequences. For this, 100 pediatric EEG recordings (patients aged 2 to 12 years) from SedLine equipment (4 frontal electrodes) were used. EEG signals were preprocessed and segmented into three states (awake, anesthesia, and surgery). Spectral (relative power, median frequency, spectral entropy, and spectral asymmetry) and nonlinear features (sample entropy and Lempel-Ziv complexity) were extracted from the three EEG states. Fast Correlation-Based Filter was used to perform automatic feature selection in the training subset (50% of the total population). Then, models based on logistic regression (LR) and linear discriminant analysis (LDA) were trained for: (i) EEG features, (ii) clinical and sociodemographic variables, and (iii) the combination of them. These models were trained independently to predict short-term (7 days) and medium-term (28 days) PBD. The LR model using both EEG and sociodemographic variables achieved the highest performance in terms of accuracy in the test group (Acc=0.92, AUROC=0.97) for short-term PBD, as well as for medium-term (Acc=0.82, AUROC=0.74). These results highlight the importance of EEG features during anesthesia induction to enhance the robustness of models trained by conventional sociodemographic variables to predict the emergence of PBD. These findings open new doors in PBD prediction, enabling tailored treatment even before the first symptoms appear.

This research was funded by "MICIU/AEI/10.13039/501100011033" and by "ERDF A way of making Europe" through the project PID2022-138286NB-I00; by GRS 2636/A/22 funded by 'Gerencia Regional de Salud de Castilla y León'; and by 'CIBER en Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN)' through 'Instituto de Salud Carlos III'.

PO-50

Investigation of the Use of Gait Analysis for Prosthetic Patients: Evaluating the Relationship Between Gait Outcome Measures and Function (K-level)

Amy Edwards, Thomas Stone

Cambridge University Hospitals, United Kingdom

Background: In the UK, there are 14 accredited gait laboratories however, only three state prosthetics as a main clinical activity. Observational gait analysis is used to determine K-level classification. K-levels reflect functional and ambulation ability and are classified from K0 (lowest) to K4 (highest). K-levels are used to prescribe prosthetic componentry and track rehabilitation. However, the literature is unclear on which outcome measures are best to assess K-level. There is no gold standard measurement of K-level. K-level determination is observational consisting of patient-perceived scores, questionnaires, and timed-walking tests. Patients can be poor at self-reporting and observed measures are subjective. Quantitative gait measures can overcome these issues.

Objectives: This study investigates the relationship between K-level and clinically

relevant quantitative gait outcome measures obtained by instrumented gait analysis. New quantitative clinical measurements of movement fluency have also been investigated.
Methods: 6 K2 and 6 K3 transfemoral amputees performed walking, sit-to-stand and sit-to-walk activities. Outcome measures investigated included temporal-spatial parameters, knee angles, hip range of motion (ROM), symmetry indices, hesitation, and smoothness.
Results: K3 participants walked significantly faster than K2 participants and with significantly greater step lengths, stride lengths and reduced periods of double support. No difference was observed in maximum knee angle in loading response. K3 users have significantly increased maximum swing knee angles on both sides compared to K2 users. K3 users also have significantly increased and more symmetrical hip ROM. No other significant differences in symmetry were present between the groups. In sit-to-stand, K3 users are smoother. In sit-to-walk, K3 users are smoother and less hesitant. Cluster analysis suggests that parameters investigated may be used to objectively classify patients and that some individuals fall between K-levels.
Conclusions: There are biomechanical differences between K2 and K3 users that can be objectively measured. Cluster analysis has been used to develop an objective tool to classify patients based on a combination of relevant gait parameters. This would reduce subjectivity in classifying patients.
Implications: The results of this study will be used to inform physiotherapists on which objective outcome measures are most relevant to ensure new prosthetic users reach their functional potential. The findings of this study could be used clinically in guiding personalised prosthetic prescription, targeting interventions and optimising rehabilitation protocols.

PO-52

Influence of the Subcutaneous Fat Layer Thickness on the Activation of the Phrenic Nerve via Non-Invasive Electrical Stimulation

Laureen Wegert, Alexander Hunold, Marek Ziolkowski, Irene Lange, Tim Kalla, Jens Haueisen
Technical University of Ilmenau, Germany

Mechanical ventilation is a life-saving technique used every day, but it is often associated with complications such as ventilator-induced diaphragmatic dysfunction. Stimulation of the phrenic nerve can keep the diaphragm active and overcome this complication. For non-invasive electrical stimulation, the anatomy and especially the thickness of the subcutaneous fat layer are important in determining the stimulation current required to activate the nerve.
Three different volume conductor models of the neck are built to represent different neck circumferences (35 cm, 41 cm, and 50 cm) including different subcutaneous fat tissue layers. The subcutaneous fat tissue thicknesses with a variation from 1 mm to 23 mm represents the variability of the German male population. The volume conductor model of the neck has a high level of anatomical detail and contains skin, subcutaneous fat tissue, muscles, bones, intervertebral discs, cartilage, thyroid, trachea, esophagus, internal air, blood vessels, and nerves. The phrenic nerve includes three fascicles, including Epineurium, Perineurium, and Endoneurium. Electrical stimulation is incorporated via two square electrodes with an edge length of 10 mm and a distance between them of 25 mm (edge to edge) placed on the neck surface at the posterior border of the sternocleidomastoid muscle. We apply a monophasic rectangular stimulation pulse with a pulse width of 150 s. Finite element simulation of the electrical potential distribution is done under steady-state conditions using COMSOL Multiphysics with a tetrahedral mesh of about 90 million elements. Electric potential values in the phrenic nerve elements are coupled with a biophysiological model of the phrenic nerve to calculate the activation threshold. The biophysiological nerve model for the evaluation of the action potential generation is based on the McIntyre-Richardson-Grill axon model. The modeled phrenic nerve axons have a diameter ranging from 5.7 m to 14 m.
The activation threshold depends on the neck circumference and the axon diameter. For the smallest neck circumference, the activation current is between 11.6 mA and 81 mA, for the middle neck circumference between 20.3 mA and 139.3 mA, and for the largest neck circumference between 29.3 mA and 225.6 mA with the minimum activation threshold for the largest axon of 14 m and the maximum value for the smallest axon of 5.7 m.
We conclude that neck circumference is an essential parameter to be taken into account for the design of individualized phrenic nerve

stimulation setups.

PO-54

Use of electrical household appliances and risk of all types of tumours: A case-control study

Muhammad Waseem Khan, ***Shabana Noori***
Balochistan University of Information Technology Engineering and Management Sciences, Pakistan

The use of electrical appliances using extremely low frequency (ELF) magnetic fields (MF) has increased in the past few years. These ELF MF are reported to be linked to several adverse health effects including (but not limited to) neurodegenerative diseases, reproductive health effects and certain types of tumours. Previous studies conducted on the topic have reported mixed effects. Based on the findings of previous studies, the international agency for research on cancer has classified ELF MFs as a possible human carcinogen. We studied the use of common household electrical appliances and suspected risk of tumours in a multi-hospital-based case-control study. Only a couple of studies have been conducted on the association between risk of tumours and use of electronic devices using low frequency (LF) MF. The study was conducted in four tertiary care hospitals (regional cancer referral centers) in district Quetta. The study participants completed questionnaires on fourteen (14) commonly used household electrical appliances. In total, 316 patients (158 tumour cases and 158 control cases) were included in the final analysis. The study results showed increased risk of tumour only for couple of devices whereas the risk of tumour for all other studied devices was below unity. An increased risk of tumour was observed for computer screen use OR: 2.77 (95% CI: 0.90 – 8.55) and use of microwave oven OR: 2.65 (95% CI: 0.73 – 9.61). The current study serves as a pilot study of primary data and will be helpful in future epidemiological research studies on the topic in the region. Further research on the risk of electronic devices using LF MF is necessary, involving diverse participants from various parts of the country.

PO-56

How Many is Enough? The Influence of patient count on structural normative template quality

Dorian Vogel[1], Jérôme Coste[2], Jean-Jacques Lemaire[2], Simone Hemm[1]
[1]University of Applied Sciences and Arts Northwestern Switzerland, Switzerland
[2]Université Clermont Auvergne, France

Structural brain templates are the foundational element for group analysis in neuroscience, providing an anatomical reference when analyzing data from different patients. When creating such templates, the topic of the appropriate number of brains to obtain a stable anatomy must be addressed. The goal of this study was to estimate the number of patients required to reach convergence in the creation of a cohort-specific anatomical template through exemplary calculations for data (Ptolemee Electrophysiologie project: IRB 5921, CE-CIC-GREN-18-03) from Clermont-Ferrand university hospital (France).
Preoperative imaging data from a group of 47 patients (Parkinson's: 30, essential tremor: 17) who received deep brain stimulation was used in an iterative, non-linear, mixed-modality, unbiased anatomical normalization pipeline published previously. It consists of iterative non-linear normalization of all original images to an anatomical template updated after each iteration and implemented to use both T1 and WAIR (white matter attenuated inversion recovery, a modality specially designed to enhance grey matter contrast). During the preoperative planning, up to 35 deep brain structures were manually labeled by a single expert. The normalization process was repeated, increasing the number of included patients, resulting in 5 different templates. The performance of the normalization was quantified using the pairwise overlap between anatomical structures across patients. A logistic function was then fitted on the median values of that score for each template to estimate the number of patients necessary to obtain a variation lower than 5%.
In this study we estimated the number of patient images required to obtain a stable group-specific anatomical template. Manual segmentation of deep brain structures was used to benchmark templates with increasing number of patients included. Results might differ depending on the specific MR sequences used.
Acknowledgements: This work was supported financially by the Swiss National Science Foundation (205320_207491)

PO-58

Assessing stress level by utilizing heart rate variability and galvanic skin response features

Sandro Radan[1], Jana Bratanić[2], Ana Sušac[1]
[1]University of Zagreb, Croatia
[2]University of Split, Croatia

This work provides a new approach to analyzing and assessing stress level by utilizing two physiological signals: photoplethysmography (PPG) and galvanic skin response (GSR), recorded with the wearable wrist-mounted system Shimmer3 GSR+. Participants were subjected to varying levels of stress induced by the Stroop color-word test and the Trier Social Stress Test (TSST).
The PPG signal was firstly bandpass filtered in the range 0.05-8 Hz by applying a second order Butterworth filter. Afterwards, peaks and their positions, which we later used for extracting the time-, frequency- and non-linear features, were extracted by applying the Event Related Moving Average (ERMA) algorithm. We extracted a total of 17 features (6 time-based, 5 frequency-based and 6 non-linear features) in accordance with the overview of heart rate variability (HRV) norms and metrics.
The GSR signal was preprocessed and decomposed using the Ledalab software leaving us with continuous tonic and phasic activity components. We extracted the peaks and their positions of the tonic component followed by identifying the skin conductance response (SCR) events. Additionally, the skin conductance level (SCL) was determined by taking the average of the GSR signal in the time window. In total, 10 features (8 time-based and 2 frequency-based features) were extracted following the guide for analysing electrodermal activity. The baseline features were used to normalize the features extracted during the experiment by dividing those features by the corresponding baseline feature.
The extracted features were fed to different machine learning algorithms (k-nearest neighbours (kNN), random forest, naïve Bayes, decision tree, etc.) to obtain stress level classification during different stages of the experiment. Each classifier was trained and validated using different subsets of selected features, whereby multifold cross-validation was performed to prevent overfitting.
We found increased classification accuracy and F1 scores of multilevel classification of stress during different stages of the experimental trials utilizing both PPG and GSR features in comparison with classifications based on solely PPG or GSR features.
The obtained results suggest that the chosen metrics can reliably be used in assessing and multilevel classification of stress during different cognitive tasks.

PO-60

Sensitivity Analysis of Reconstruction Fiber Tracking Parameters from Diffusion Tensor Magnetic Resonance Imaging of Reanimated Ex Vivo Swine Hearts

Neal Duong, Paul A. Iaizzo
University of Minnesota, United States

This study investigates the optimization of cardiac fiber orientation mapping of formalin-fixed swine hearts through the applications of diffusion tensor magnetic resonance imaging (DT-MRI) and advanced fiber tracking techniques. DT-MRI, a modality that gauges the movement of water molecules in soft tissue, is a powerful tool for understanding the relative fiber orientations within cardiac structures. Utilizing the Dipy fiber tracking software and employing customized denoising methods, our research focuses on unraveling the sensitivity of parameter selections in reconstructing fiber orientations within both the left and right ventricles.
The analysis framework involves a multi-step process, commencing with the reanimation of hearts, followed by fixation in formalin, and the strategic application of agarose solutions to reduce imaging artifacts. Subsequent scanning using a Siemens 3T MRI machine, coupled with image file conversions to a NIFTY format for compatibility with Dipy; enabled a comprehensive analysis of cardiac fiber orientations. Manual segmentation utilizing ITK-SNAP further refines each dataset to solely myocardial structures, minimizing noise and facilitating focused computational analyses over traditional thresholding methods.
Parameters critical to fiber tracking, such as step size, stopping criteria based on fractional anisotropy, and maximum angle deviation, were systematically adjusted to explore their sensitivity for optimal ventricular reconstructions. The study carefully evaluated these parameters across a spectrum, ranging from step sizes of 0.025 to 0.3, stopping criteria from 0.025 to 0.3, and max angle thresholds spanning from 15 to 75 degrees. Visual assessments, supplemented by user-assigned

ranks, aided in evaluating representation fidelities by comparing reconstructed images with established research models. Optimized fiber tracking techniques identified crucial parameters; notably a stopping threshold below 0.1 and an angle limit between 45 and 60 degrees.
The present findings have promising implications for clinical applications, not only in enhancing diagnostic accuracies but also perhaps in guiding electrophysiology interventions. We envision applications such as determining optimal left bundle branch pacing depths, visualizing ventricular ablations, and characterizing myocardial infarctions' morphologies and location. Furthermore, our research contributes valuable physiological context to ventricular function and electrical behaviors, thereby providing critical inputs for computational modeling. In the future, our group aims to extrapolate these optimized techniques to human heart specimens within our Visible Heart human specimen library, fostering additional translational models for understanding human cardiac fiber orientations. The potential impact of these findings extends beyond swine models, and may provide promising advancements in the comprehension and application of cardiac imaging in both preclinical and clinical settings.

PO-62

Insights into Magnetomotive Ultrasound: Evaluating Key Parameters for Enhanced Imaging

Ariane Sanches, Nicholas Zufelato, David Collazos-Burbano, João Henrique Uliana, Théo Pavan, Antonio Adilton Carneiro
University of Sao Paulo, Brazil

Magnetomotive ultrasound is a recent technique that combines magnetism and ultrasound imaging to localize magnetic nanoparticles within tissues and determine their viscoelastic properties based on the shear wave velocity. For the optimal operation of this technique, key factors include the intensity and gradient of the magnetic field, the transient characteristics and width of the applied pulse, as well as the magnetization and concentration of the nanoparticle, among others. The primary objective of this study is to evaluate the influence of these parameters on misleading results when not considered in data collection. For this purpose, we applied citrate-coated manganese ferrite nanoparticles (MnFe2O4@CIT) in three concentrations (1%, 2% and 3%) within gelatin phantoms. Then, we varied systematically the distance from the magnetizing coil and the amplitude and duration of the excitation pulse. Next, by using an ultrasound platform (Verasonics Vantage System) we acquired the RF data and reconstructed the echo maps, being able to additionally assess the nanoparticles localization and viscoelasticity parameters of the phantom samples. Results highlight the significant decrease of the nanoparticles displacement when distance from the coil is increased by just a few millimeters or the inclusion concentration is reduced. Furthermore, changing the pulse duration resulted in different spectral content of the acquired signals, which is useful for viscoelasticity analysis via the shear wave velocity maps. In conclusion, standardization of such parameters can provide more accurate information of the effects of nanoparticles within tissues and the corresponding properties gathered from these studies.

PO-64

Unveiling the phenolics of chestnut honey-based propolis and in silico phytoestrogen activity

Idris Arslan
Zonguldak Bülent Ecevit University Department of Biomedical Engineering Zonguldak Turkey, Turkey

An estrogen deficiency at menopause induces climacteric symptoms in humans including hot flashes, diaphoresis, sleep disturbances and progressive bone loss. A phytoestrogen can be defined as a plant-derived xenoestrogen molecule with estrogenic activity and not associated with the endocrine system. The present study aims to investigate the chemical constituents and their potency as a phytoestrogen of chestnut-honey based propolis from Çarşamba district (Sam-sun, Turkey) by in silico molecular docking simulation. The present study evidenced the phenolic constituents from chestnut-honey based propolis possess phytoestrogen activity.

PO-66

Enhancing Cross-Domain Adaptability of Existing Computer-Aided Endoscopic Lesion Detection Using Plug-and-Play Tracker

Yijie Ku, Hui Ding, Guangzhi Wang
School of Biomedical Engineering, Tsinghua University, China

Computer-aided detection (CADe) for endoscopy can help physicians to locate and identify lesions better, but there are still many false positives (FP) when processing cross-domain data. This paper proposes SE-SORT, a plug-and-play tracker, designed to be seamlessly integrated as a post-processing plugin into existing CADe systems to enhance the adaptability to cross-domain data. The proposed tracker adds trajectory initialization thresholds into the tracking association strategy, reducing the impact of high confidence FPs on the matching process. Experiments show that the modified tracker effectively reduces the impact without significantly affecting the processing speed. This allows the detector of CADe system to tolerate lower detection confidence thresholds, thus improving the overall accuracy on cross-domain data. Compared to existing SORT trackers, the proposed tracker exhibits better accuracy and higher efficiency in endoscopic lesion detection and tracking. This work will help to improve the generalization and expanding the clinical application scope of related works on endoscopic real-time CADe.

PO-68

Design and Analysis of a Biomedical Orthosis for Clubfoot Corrective Device

Shahrol Mohamaddan
Shibaura Institute of Technology, Japan

Clubfoot is a common congenital foot deformity that leads to constant pain and significant limitations if left untreated or not treated adequately. The most used method for treating clubfoot is the Ponseti method. It involves a correction phase where about five plaster casts are applied and changed weekly. This treatment lasting about 2 to 3 months, is the most chosen method due to its high success rate. However, treated babies often experi-ence skin complications caused by stiff and tight casts. Previous research showed that viable solutions already exist including orthoses. In this re-search, a developed method known as VDI 2221 was applied and the printable orthosis using 3D printer was selected as an alternative to Ponseti meth-od. Calculations and finite element method (FEM) analysis demonstrated that the orthosis made of PA6-CF provides sufficient stiffness and strength, assuming the weight force of the foot is 10 N. The selected design was de-veloped based on requirements and functional analysis, effectively mitigat-ing the disadvantages of the Ponseti method. The developed orthosis can be manufactured globally using the 3D printing process, with a manufacturing cost of around €150, excluding assembly costs. In summary, a new solution was proposed within the same treatment method, effectively eliminating skin complications, and enabling cost-effective manufacturability on a global scale.

PO-70

A complex spinal surgery lifting system for prone positioning

Lutong Li[1], Stuart Watson[2], Glyn Smurthwaite[2], John Large[2], Andrew Weightman[1], Glen Cooper[1]
[1]The University of Manchester, United Kingdom
[2]Salford Royal NHS Foundation Trust, United Kingdom

Spinal surgery is one of the fastest-growing surgical procedures and improving prone position is always a big challenge, specifically for patients with ad-vanced deformity. Current spinal surgery tables (e.g. Allen Table, Hillrom LTD, Newbury, Berks, UK) can meet the simple positioning requirement, but they lack the necessary flexibility and customisation to adequately address the needs of patients with more complex requirements, such as patients with ad-vanced deformities. This study identified the clinical challenge of prone positioning through a literature review and focus group with six professionals (one clinical engineer, two spinal anaesthetists and three mechanical engineers) and proposes a solution to address the problem. A two-stage study was conducted. A detailed design specification of the smart lifting system was developed based on the literature review and focus group results, which includes four cat-egories, 'Hardware', 'Software', 'Safety' and 'User's preference' requirements in the first stage. The second stage is the design and evaluation of the smart lifting system. According to the design requirements, a smart lifting system is designed for spinal surgery with 170 kg loading capability and 250 mm lifting height. Multiple iterations of focus groups involving professionals were under-taken to assess the smart lifting system, and it successfully satisfies all identified design requirements. This study proposes a potential solution that can be used to address the difficulty of positioning patients with advanced deformities and reduce the need to use manual handling of patients during surgery.

Authors' Index