

BIOMEDENG26

Abstract Booklet

Scheduled oral and rapid-fire poster presentations

3-4 September 2026
University of Liverpool

218 abstracts · 36 sessions

About this booklet

This booklet contains only abstracts that appear in the final BioMedEng26 delegate programme and for which a full submission record was supplied. The schedule, session IDs, session names, rooms and presentation order follow that programme.

Keynotes, partner presentations and empty timetable slots are excluded. Abstract titles, author lists and descriptions are reproduced from the submitted abstract records; programme presenter details are shown separately where available.

218	152	66	36
scheduled abstracts	oral presentations	rapid-fire posters	sessions

Session directory

Date	Time	ID	Session	Room	Abstracts
3 Sep	10:20-11:20	001	Aortic and Cardiovascular Mechanics	Space Four	4
3 Sep	10:20-11:20	002	Biomedical Imaging I: diagnostic imaging and sensing	Space Five	5
3 Sep	10:20-11:20	003	Musculoskeletal Biomechanics I: gait, joints and motion	Space Six	6
3 Sep	10:20-11:20	004	Orthopaedic, Dental and Prosthetic Engineering	Space Seven	6
3 Sep	10:20-11:20	005	Metamaterials for Health	Wolfson Lecture Theatre	6
3 Sep	13:00-14:00	006	AI in Bioengineering I: imaging, sensing and predictive analytics	Space One and Two	6
3 Sep	13:00-13:50	007	Computational Modelling I: multiscale physiology and transport	Space Four	5
3 Sep	13:00-14:00	008	Biomaterials I: therapeutic materials and drug delivery	Space Five	5
3 Sep	13:00-14:00	009	TADCT Sponsored Session: Aortic Haemodynamics and Mechanics	Space Six	5
3 Sep	13:00-14:00	010	AI in Health and Digital Twins: clinical decision support and personalised modelling	Space Seven	5
3 Sep	13:00-14:00	011	Tissue Engineering I: scaffolds and regenerative platforms	Wolfson Lecture Theatre	6
3 Sep	14:00-14:18	P01	AI in Bioengineering	Space One and Two	8
3 Sep	14:00-14:14	P02	Computational Modelling and Digital Twins	Space Four	7
3 Sep	14:00-14:20	P03	Biomaterials	Space Five	10
3 Sep	14:00-14:20	P04	Cardiovascular Mechanics and Biomedical Imaging	Space Six	10
3 Sep	14:00-14:18	P05	Clinical Diagnostics	Space Seven	9
3 Sep	14:00-14:14	P06	Tissue Engineering and Women’s Health	Wolfson Lecture Theatre	7
3 Sep	14:14-14:18	P07	Metamaterials for Health	Wolfson Lecture Theatre	2

Date	Time	ID	Session	Room	Abstracts
4 Sep	09:10-09:28	P08	Musculoskeletal and Sports Biomechanics	Space Four	8
4 Sep	09:10-09:20	P09	Orthopaedic, Skin and Soft Tissue	Space Five	5
4 Sep	10:20-11:20	O12	AI in Bioengineering II: wearables and clinical deployment	Space One and Two	6
4 Sep	10:20-11:20	O13	Computational Modelling II: patient-specific simulation	Space Four	6
4 Sep	10:20-11:20	O14	Skin and Soft-Tissue Mechanics	Space Five	5
4 Sep	10:20-11:20	O15	Biomedical Imaging II: advanced imaging and physiological measurement	Space Six	6
4 Sep	10:20-11:20	O16	Tissue Engineering II: vascular and organ-on-chip models	Space Seven	6
4 Sep	13:00-14:00	O17	Tissue Engineering III: neural, bone and therapeutic implants	Space One and Two	6
4 Sep	13:00-14:00	O18	Computational Modelling III: organ-scale biomechanics	Space Four	6
4 Sep	13:00-14:00	O19	Biomaterials II: biofabrication and sustainable manufacture	Space Five	6
4 Sep	14:00-15:00	O20	Assistive Technology and Diagnostic Innovation	Space One and Two	6
4 Sep	14:00-15:00	O21	Musculoskeletal Biomechanics II: bone, muscle and rehabilitation	Space Four	6
4 Sep	14:00-14:50	O22	UKSB - Biomaterials	Space Five	5
4 Sep	15:20-16:20	O23	Clinical Diagnostics and Point-of-Care Systems	Space One and Two	6
4 Sep	15:20-16:20	O24	Neural Systems and Brain Imaging	Space Four	6
4 Sep	15:20-16:20	O25	Biomaterials III: smart materials and advanced manufacture	Space Five	5
4 Sep	15:20-16:20	O26	Craniofacial, Soft-Tissue and Sports Biomechanics	Space Six	6
4 Sep	15:20-16:20	O27	Bioengineering Education	Space Seven	6

Contents

Thursday 3 September 2026

5

O01 · Aortic and Cardiovascular Mechanics	5
O02 · Biomedical Imaging I: diagnostic imaging and sensing	9
O03 · Musculoskeletal Biomechanics I: gait, joints and motion	14
O04 · Orthopaedic, Dental and Prosthetic Engineering	20
O05 · Metamaterials for Health	26
O06 · AI in Bioengineering I: imaging, sensing and predictive analytics	32
O07 · Computational Modelling I: multiscale physiology and transport	38
O08 · Biomaterials I: therapeutic materials and drug delivery	43
O09 · TADCT Sponsored Session: Aortic Haemodynamics and Mechanics	48
O10 · AI in Health and Digital Twins: clinical decision support and personalised modelling	53
O11 · Tissue Engineering I: scaffolds and regenerative platforms	58
P01 · AI in Bioengineering	64
P02 · Computational Modelling and Digital Twins	72
P03 · Biomaterials	79
P04 · Cardiovascular Mechanics and Biomedical Imaging	89
P05 · Clinical Diagnostics	99
P06 · Tissue Engineering and Women's Health	108
P07 · Metamaterials for Health	115

Friday 4 September 2026

117

P08 · Musculoskeletal and Sports Biomechanics	117
P09 · Orthopaedic, Skin and Soft Tissue	125
O12 · AI in Bioengineering II: wearables and clinical deployment	130
O13 · Computational Modelling II: patient-specific simulation	136
O14 · Skin and Soft-Tissue Mechanics	142
O15 · Biomedical Imaging II: advanced imaging and physiological measurement	147
O16 · Tissue Engineering II: vascular and organ-on-chip models	153
O17 · Tissue Engineering III: neural, bone and therapeutic implants	159
O18 · Computational Modelling III: organ-scale biomechanics	165
O19 · Biomaterials II: biofabrication and sustainable manufacture	171
O20 · Assistive Technology and Diagnostic Innovation	177
O21 · Musculoskeletal Biomechanics II: bone, muscle and rehabilitation	183
O22 · UKSB - Biomaterials	189
O23 · Clinical Diagnostics and Point-of-Care Systems	194
O24 · Neural Systems and Brain Imaging	200
O25 · Biomaterials III: smart materials and advanced manufacture	206
O26 · Craniofacial, Soft-Tissue and Sports Biomechanics	211
O27 · Bioengineering Education	217

Thursday 3 September 2026

001**Aortic and Cardiovascular Mechanics****Thursday 3 September 2026** · 10:20-11:20 · Space Four**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Dissecting the Dissection: Nanoscale Collagen Mechanics Across the Flap, True and False Lumen of the Human Aorta

Mr Bojin Marinov, Dr. Riaz Akhtar, Dr. Jill Madine, Prof. Mark Field

Scheduled presenter: Mr Bojin Marinov · **Organisation:** University of Liverpool · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 180

DESCRIPTION OF PROPOSED TALK

Introduction

The aorta is the largest blood vessel, delivering blood from the heart to all cells. Thoracic aortic dissection (TADs) is life-threatening, characterised by a tear in the inner aortic layer allowing blood to separate its layers. This creates a false lumen, compromising blood flow and increasing rupture risk. TAD is associated with biomechanical failure of radially oriented collagen fibrils. Collagen-degrading enzymes (MMP-2, MMP-9) are overexpressed in TAD aortic walls [1-3]. This study compares biomechanical properties of collagen fibrils in the flap, true and false lumen, correlating findings with morphological defects to better characterise mechanobiological differences in aortic dissection.

Methods

Aortic tissues from 5 TAD patients undergoing surgery were obtained with ethical approval (Liverpool University Biobank). Samples were cryosectioned (5 μm) and analysed using high-resolution atomic force microscopy (AFM). Morphology of flap, false and true lumen was examined with an RTESPA-300 tip, and mechanical properties measured using PeakForce QNM [4]. Analysis focused on collagen fibril organisation and stiffness, with DMT measurements taken from visible fibrils.

Results

& Discussion: Collagen fibrils in flap and false lumen showed degradation, disrupted D-period, high variability, and disorganisation due to cross-link disruption. The flap showed 58% higher elastic modulus (3.3 ± 1.6 GPa) than true lumen (2 ± 0.79 GPa) ($p < 0.01$). The false lumen showed 22% higher modulus (2.6 ± 0.79 GPa) than true lumen, but not significant, with high variability. The false lumen D-period (71.46 ± 5.4 nm) was significantly higher than true lumen (67.5 ± 1.2 nm) ($p < 0.01$). The flap showed a slightly higher D-period (68.9 ± 3.3 nm) than the true lumen, but not significant.

Conclusion

Significant differences in collagen fibril biomechanics were observed across aortic dissection regions with the flap and false lumen showing degraded and disorganised collagen with increased stiffness. These findings provide new insight into the nanoscale structural failure mechanisms underpinning aortic dissection and support the potential development of biomechanical or imaging-based biomarkers for improved risk stratification, disease monitoring, and future targeted therapeutic intervention.

001**Aortic and Cardiovascular Mechanics****Thursday 3 September 2026** · 10:20-11:20 · Space Four**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Studying the role of RBC aggregation and deformability on the transport of Red Blood Cells

Miss Gladys Diaz Armas, Dr. Simon Tupin, Dr. Christopher Rowlands, Dr. Joseph van Batenburg-Sherwood

Scheduled presenter: Miss Gladys Diaz Armas · **Organisation:** Imperial College London · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 196

DESCRIPTION OF PROPOSED TALK

INTRODUCTION

In diabetes, red blood cell (RBC) aggregation increases and deformability decreases. We posit that these changes contribute to microvascular symptoms by raising blood viscosity and altering RBC transport. However, despite extensive research on the effects of RBC deformability and aggregation, there is no consensus on precisely how they can affect flow in different microvascular networks or even in the simplest geometry, a long straight vessel. Here, we measure spatial distributions of human RBCs at physiologically relevant haematocrit in a long straight microchannel. We modify healthy samples to mimic different effects of disease, providing a broad data set to investigate the complex interplay between RBC properties and flow behaviour along a channel.

METHODS

RBCs from four healthy donors were washed and resuspended at 25% haematocrit in a PBS-Optiprep mixture. Samples were modified to provide three levels of aggregation (using Dextran 500kDa) and three levels of deformability (using glutaraldehyde). Blood samples were perfused through a square 44 μm -wide PDMS channel at average velocities of $\sim 1, 2, 4$ and 8 mm/s . Optical densitometry was used to measure local haematocrit profiles at six positions between the inlet and 570w downstream. Profiles were characterised by a bluntness angle; negative values indicate RBC centre-focusing, while positive values indicate a two-peak profile with elevated near-wall haematocrit

RESULTS

For all fluids, profiles generally developed within 200w, with angles initially rising to a maximum within 20w before decreasing to their developed values. These maxima correspond to a two-peak profile shape, which was more pronounced at higher velocities.

For the normal sample, developed profiles showed negative angles that increased towards zero with increasing velocity. Aggregation increased centre-focusing at low flow rates, but at high flow rates led to positive 'twin-peak' profiles. RBC stiffening had little effect at low flow rates but produced more negative angles and reduced velocity dependence at higher flow rates.

CONCLUSIONS

We provide a uniquely systematic dataset comprising 5 working fluids, 4 flow rates and 6 channel locations, repeated for four donors, with aggregation, deformability and media viscosity characterised for each fluid. We also have particle image velocimetry data in addition to optical densitometry, so we can investigate how local haematocrit affects local velocity. The described results demonstrate clear influences of RBC deformability and aggregation on the development of haematocrit profiles, a critical component of RBC transport in microvessels. Future work will interrogate the same fluids in branching channels mimicking microvascular networks.

001**Aortic and Cardiovascular Mechanics****Thursday 3 September 2026** · 10:20-11:20 · Space Four**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood**Collagen fibril ultrastructure and nanomechanical properties in Coarctation of the Aorta: association with biochemistry, histology and hypertension.**

Mr Joshua Preston, Professor Gregory Lip, Professor Attilio Lotto, Dr Riaz Akhtar

Scheduled presenter: Mr Joshua Preston · **Organisation:** University of Liverpool · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 9**DESCRIPTION OF PROPOSED TALK**

Coarctation of the aorta (CoA) is a common congenital heart defect, typically characterised by a narrowing of the aorta at the aortic isthmus, obstructing blood flow. It is often detected and surgically repaired within the first few weeks of life. However, a large proportion of patients still experience increased mortality compared to the general population, which is often associated with the development of persistent hypertension. The underlying mechanisms of CoA and its associated persistent hypertension remain elusive.

Elevated aortic stiffness is associated with persistent hypertension in CoA patients, where a key determinant of aortic biomechanical properties is the composition of the extracellular matrix (ECM). The present study aimed to characterise the mechanical and biochemical properties of collagen fibrils in CoA tissues, and related histopathological and biochemical properties. Aortic samples containing the coarctation site and a section of internal control tissue proximal and distal to the coarctation were collected from paediatric patients undergoing surgical repair for CoA.

Atomic force microscopy (AFM) was utilised to assess collagen ultrastructure and mechanical properties. Collagen fibril stiffness was elevated in the CoA site relative to distal and proximal regions: 21 % and 26 % higher than the distal ($p=0.071$), and proximal regions ($p=0.023$) respectively. Each of the 3 regions demonstrated areas of disorganised collagen fibrils, and elevated D-periodicity relative to the expected 67nm (CoA; 68.9nm, Distal; 68.4nm, Proximal; 69.1nm). A statistically significant positive correlation between collagen fibril D-period length and collagen stiffness was identified ($r=0.287$, $p=0.012$).

Biochemical analyses identified heterogeneity in the ECM composition throughout the proximal, distal, and coarctation site regions. Elevated relative levels of both collagen III and VI were present in the coarctation site compared to proximal and distal regions, however no statistical significance was reported. Elastin concentrations were similar between the groups, but histological analysis revealed a significantly greater elastic lamella count in the proximal region of 55.13 when compared to 42.80 in the coarctation site ($p=0.029$). No significant differences in whole Glycosaminoglycan concentrations were found between the regions, but additional dot blots showed a greater relative level of chondroitin sulphate, heparan sulphate, and versican in the proximal regions compared to the distal regions and coarctation site. The coarctation site demonstrated the greatest aggrecan level of the three regions.

This study provides an insight into the potential pathways underlying the development of persistent hypertension post-repair in CoA patients, highlighting potential mechanisms to target for future research and treatment options.

001**Aortic and Cardiovascular Mechanics****Thursday 3 September 2026** · 10:20-11:20 · Space Four**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Elastin Quantification in Aortic Dissections and association with extracellular matrix degradation

Sinead Gibbons, Dr Derek Magee, Dr Riaz Akhtar, Dr Jill Madine, Professor Mark Field

Scheduled presenter: Dr Derek Magee · **Organisation:** University of Leeds · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 139

DESCRIPTION OF PROPOSED TALK

Introduction

Digital pathology and AI-based image analysis are becoming standard tools in biomedical research, allowing quantitative analysis of tissue microarchitecture in diseases such as cancer. We have developed an image analysis pipeline for the quantification of elastin in Aortic Dissection tissue and applied this analysis to a set of collected clinical samples with different disease types (acute vs chronic), illustrating that we can quantitatively differentiate such tissue types. The eventual aim of this work is to provide feedback to surgeons on the excised tissue which may help guide subsequent patient follow-up.

Methods

Aortic tissue was excised from patients who were undergoing surgery for an acute or chronic aortic dissection (acute $n = 13$, chronic $n = 17$). The samples were preserved with a neutral buffered formalin and were then dehydrated, embedded in paraffin wax and sectioned. The sections were stained using the VVG stains according to standard protocol. Digital Images were captured on an Axio slide scanner (Carl Zeiss Microscopy, White Plains, NY, USA) at a 20x magnification. We trained a 5-class (Elastin, Background, Inflammation, Artifact, Other) neural network model (UNET) by annotating examples of each class on approximately 30 images using the HeteroGenius MIM software, and developed bespoke software to trace and quantify fibre thickness, local directionality consistency, fibre length and fibre separation based on the UNET output.

Results

Initial results show a statistically significant reduction of Elastin between the acute and chronic state. Analysis of other parameters is ongoing.

Discussion

We have shown that quantitative methods based on Digital pathology and AI-based Image Analysis can differentiate between disease states in Aortic Dissections. Our eventual aim is to analyse the distribution of such differences across a sample (e.g. close to the dissection margin, and closer to the centre of the excised sample) so as to feed this information to vascular surgeons who have carried out the procedure. Diseased tissue at the dissection margin may indicate that insufficient tissue has been removed and may point to future complications. In this way we hope to improve surgical outcomes.

002**Biomedical Imaging I: diagnostic imaging and sensing****Thursday 3 September 2026** · 10:20-11:20 · Space Five**Chairs:** Dr Ahmed Abass · Dr Rory Bennett

Large Area Atomic Force Microscopy Mapping for Mechanical Characterization of Biomaterials, Cells, and 3D Tissue Models

Dr Alexander Dulebo, MSc Jordan Turney, Prof Lewis Francis, Prof Maxime Mahe, MSc Victor Perreux

Scheduled presenter: Dr Alexander Dulebo · **Organisation:** Bruker · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 40

DESCRIPTION OF PROPOSED TALK

Biomaterials play a central role in advancing healthcare, from fundamental studies of cell-material interactions to the development and translation of clinically relevant tissue models. A key challenge in this field is the quantitative characterization of mechanical properties across heterogeneous and structurally complex systems such as hydrogels, cell layers, spheroids, and organoids. Atomic force microscopy (AFM) offers unmatched sensitivity for probing stiffness, adhesion, and viscoelasticity at the nano and microscale, yet conventional AFM approaches are often limited by small scan sizes, surface roughness, and low throughput, restricting their applicability to large or three dimensional biomaterial constructs.

Here, we present a newly developed large area nanomechanical mapping approach that overcomes these limitations through fully automated coordination of AFM head motors with XYZ piezo motion, combined with a newly designed large range, high accuracy positioning stage. This integrated solution enables continuous, high resolution mechanical mapping over extended areas without user intervention, significantly improving measurement robustness, throughput, and reproducibility-key requirements for biomaterials research and translational studies.

We validate the approach using hydrogel systems spanning physiologically relevant stiffness ranges (1-50 kPa), demonstrating centimetre scale mapping with detailed mechanical property distributions. We further apply the method to biomaterial supported 2D cell cultures, high grade serous ovarian cancer spheroids exceeding 100 μm in height, and extremely soft (<1 kPa) iPSC derived organoids. Even in the presence of pronounced surface roughness, reliable mechanical characterization is achieved, highlighting the suitability of the technique for complex and clinically relevant 3D models.

Overall, this large area AFM nanomechanical mapping platform represents a significant advancement for biomaterials characterization, bridging fundamental materials science with biologically and clinically relevant applications. It opens new opportunities for studying soft and heterogeneous biomaterials, engineered tissues, and advanced in vitro models, supporting their translation toward biomedical and healthcare applications.

002**Biomedical Imaging I: diagnostic imaging and sensing****Thursday 3 September 2026** · 10:20-11:20 · Space Five**Chairs:** Dr Ahmed Abass · Dr Rory Bennett

TomoSAXS enables the 3D investigation of fibrillar nanostructure across intact human organs

Dr Alissa Parmenter, Elis Newham, Jishizhan Chen, Tim Snow, Joseph Brunet, Valentin Vinci, Jakub Drnec, Alexandre Bellier, Nick Terrill, Peter Lee, Himadri Gupta

Scheduled presenter: Dr Alissa Parmenter · **Organisation:** University College London · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 60

DESCRIPTION OF PROPOSED TALK

Hierarchical fibrous architectures govern the mechanical function of many biological tissues, yet linking nanoscale fibrillar properties to organ-scale structure remains a major challenge. In the intervertebral disc (IVD), collagen organisation across length scales underpins load-bearing behaviour and degeneration, but existing techniques cannot simultaneously resolve nanoscale fibril structure and whole-organ architecture in intact human samples.

We present TomoSAXS [1], a multimodal imaging framework combining small-angle X-ray scattering (SAXS) with phase-contrast computed tomography to enable correlative 3D mapping of collagen structure from the nano- to organ scale. Unlike existing 3D SAXS approaches, which are constrained to millimetre-scale specimens due to acquisition complexity [2], TomoSAXS enables reconstruction of fibrillar properties across intact human IVDs (~5 cm), representing an order-of-magnitude increase in accessible sample size.

Intact human IVDs (n=3) were imaged with hierarchical phase contrast tomography (HiP-CT) [3] (4-10µm voxel size) at the European Synchrotron Radiation Facility (ESRF) beamline BM18, and correlatively with high energy (75keV) tomographic SAXS (beam size 100µm) at ESRF beamline ID31. Fibre tracing (Avizo XFiber) and orientation analysis were performed to parameterise collagen architecture, enabling quantification and 3D mapping of fibre direction and curvature. Fibre orientations were incorporated into the TomoSAXS reconstruction pipeline, enabling 3D SAXS reconstruction via 3D diffraction modelling and singular value decomposition. This approach allows per-fibre quantification of nanoscale collagen properties, including fibril diameter and D-period, which represents fibrillar pre-strain in the IVD.

This approach reveals, for the first time, spatially resolved maps of collagen micro- and nanostructure across intact human IVD. We identify systematic variations in fibril diameter and pre-strain linked to tissue architecture, and demonstrate that these nanoscale patterns are disrupted in regions associated with degeneration, including osteophyte formation and neovascularisation. HiP-CT enables visualisation and quantification of collagen microarchitecture, as well as visualisation of cells in their native environment. Combined with the quantification of extracellular matrix properties from SAXS, these findings establish a direct structural link between hierarchical organisation and pathological change.

TomoSAXS provides a scalable platform for interrogating structure-function relationships in intact human tissues, addressing a critical gap in multiscale characterisation. By enabling incorporation of experimentally derived nanoscale parameters into tissue-scale mechanical models, this approach has potential to improve predictive modelling of degeneration and inform the design of regenerative strategies and biomimetic materials. More broadly, the method opens new opportunities for translating nanoscale structural insights into clinically and industrially relevant applications in musculoskeletal health and beyond.

002**Biomedical Imaging I: diagnostic imaging and sensing****Thursday 3 September 2026** · 10:20-11:20 · Space Five**Chairs:** Dr Ahmed Abass · Dr Rory Bennett

Classification of placenta accreta spectrum using machine learning and texture analysis of MR images

Miss Suzie Coldman, Guanglong Zhou, Dengjiang Wu, Lingzhong Guo, Andrew Melbourne, Anna David, Nada Mufti, Luca Gherardini, Jose Sousa, Elspeth Whitby, Xinshan Li

Scheduled presenter: Dr Xinshan Li · **Organisation:** University of Sheffield · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 62

DESCRIPTION OF PROPOSED TALK

Introduction

Placenta accreta spectrum (PAS) is often diagnosed with MRI. However, only 30-66% of PAS pregnancies are identified prenatally [1-3], due to limited resources and lack of expert radiologists. We aimed to classify PAS using texture and shape features from placental MRI and machine learning (ML).

Materials and Methods

A total of 83 control and 41 PAS MRIs were obtained from hospital 1 and 8 control and 6 PAS MRIs were obtained from hospital 2. MRIs were acquired during 19-38 weeks gestation (sagittal T2 HASTE sequence, Siemens 1.5T scanner). The presence of PAS was confirmed with histological assessment. Each placenta was manually segmented and 2525 texture/shape features extracted using PyRadiomics (version 3.0.1). The hospital 1 dataset was split for internal training and testing (80/20); the hospital 2 dataset was used for external testing only. Feature selection involved intraclass correlation coefficient, zero-variance and variance inflation factor filters and logistic regression (10-fold cross-validation (CV) and 750 bootstraps). Seven ML algorithms were trained on the selected features (15-fold CV): Logistic Regression (LR), Support Vector Machine (SVM), Random Forest (RF), Gradient Boosting (GB) and CACTUS Probabilistic (PB), Degree (DG) and PageRank (PR) [4, 5]. Ensemble methods were tested with soft and hard voting. 25 repeats were used, where each repeat used a different random seed to split the internal set into training and testing.

Results

Surface volume ratio, low grey level zone emphasis and total energy were selected for classification; the latter two indicate the presence of dark zones on MRI. The highest mean accuracies were exhibited by CACTUS PB (0.76 ± 0.10) on the internal and GB (0.80 ± 0.12) on the external test set. No significant differences were observed between models on the internal test set. GB significantly outperformed SVM and all CACTUS algorithms on the external test set ($p < 0.05$).

The best ensemble methods were GB-SVM and GB-LR with hard voting, both achieving mean accuracies of 0.77 ± 0.08 and 0.81 ± 0.11 on the internal and external test sets respectively.

Discussion

and Conclusions

Texture and shape features selected for classification were consistent with dark bands and shape changes associated with PAS. Ensemble methods with multiple classification algorithms minorly improved the overall classification performance compared with individual classification algorithms. In future, this work will be extended to include clinical features indicative of PAS, and placental position information.

002**Biomedical Imaging I: diagnostic imaging and sensing****Thursday 3 September 2026** · 10:20-11:20 · Space Five**Chairs:** Dr Ahmed Abass · Dr Rory Bennett

Stereo-Digital Image Correlation with Minimally-Invasive Surgical Cameras - A Validation Study

Miss Izabela Nowakowska, Miss Ciara Durcan, Mr Mahmood Saleh, Mr Ross Henrywood, Mr William MacPherson, Mr Robert Reuben, Mr Yuhang Chen

Scheduled presenter: Miss Izabela Nowakowska · **Organisation:** Heriot-watt University · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 105

DESCRIPTION OF PROPOSED TALK

Digital image correlation is an image-based strain measurement technique that has been widely adapted within the field of biomechanics, from detecting cancerous tissue by its mechanical properties[1] to measuring the carotid pulse signal on the neck [2]. However, despite its many uses, the technique is yet to be adapted in clinical practice. DIC relies on tracking unique patterns across an image stack of a deforming material. Trade-offs between image quality and adaptation for surgical environments often result in images with glare and low contrast difference between the tracked pattern and image noise. When used for DIC analysis, these noise sources propagate and can limit the number of features matched or cause incorrect matches, which produce large outlier in strain values, hindering the implementation of DIC in clinical use.

We developed a methodology to use images taken with a stereo-vision laparoscopic surgical camera in a stereo-DIC framework. Glare was removed from the images by translating into the HSV colour space and extracting the saturation channel. A combination of Gaussian blur and Contrast Limited Adaptive Histogram Equalization smoothed the graininess in the images while enhancing the feature contrast. A custom stereo-DIC framework was developed to process noisy data, utilising NCorr[3] to match features across images in respective camera feeds. The matched points were then triangulated into 3D point clouds in 3D coordinates with corresponding displacements[4], with poorly matched points filtered out. In order to smooth the data while calculating the local strains, a running least squares approach based on a set of nearest neighbours was used.

The system was validated on dogbone samples with instrumented uniaxial tension test (Instron). Once validated, a case study was done on a 1:2 scale silicon liver phantom, cast with a Young's modulus of 4kPa to match the mechanical properties of human liver tissue [5]. The phantom was speckled with red acrylic paint and covered with oil to mimic the natural shine of liver tissue. Tension was applied using surgical instruments and recorded by a laparoscopic camera provided by CMR Surgical (Cambridge, UK). It was found that the method allowed for DIC analysis of images NCorr could not correlate without certain pre-processing. The method shows promise, with good robustness and accuracy, for adaptation of stereo-DIC analysis with standard surgical cameras, facilitating its implementation in a clinical context.

002**Biomedical Imaging I: diagnostic imaging and sensing****Thursday 3 September 2026** · 10:20-11:20 · Space Five**Chairs:** Dr Ahmed Abass · Dr Rory Bennett

Nonlinear ultrasonics for bone sensing

Mr Andrew Carey, Dr Andriejus Demčenko, Professor Jonathan Cooper

Scheduled presenter: Mr Andrew Carey · **Organisation:** University of Glasgow · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 57

DESCRIPTION OF PROPOSED TALK

Osteoporosis affects over 200 million people worldwide and has serious consequences for individual health and quality of life. Current gold-standard diagnostic methods, such as dual X-ray absorptiometry (DXA) and quantitative computed tomography (QCT), lack the sensitivity required to detect microstructural changes in bone that precede disease onset. By the time these changes become detectable, available treatments are often of limited efficacy and may involve significant side effects. This motivates the development of a safe, sensitive, non-ionising quantitative technique capable of identifying pre-osteoporotic changes and enabling early intervention.

Linear quantitative ultrasonic techniques offer an alternative to DXA and QCT, but their sensitivity and resolution are inherently limited. Nonlinear ultrasonic approaches, such as low-power parametric wave mixing, overcome these limitations by exploiting the nonlinear interaction of two incident waves to generate a combined-frequency response. This response is highly sensitive to bone microstructure and nonlinear elastic properties, enabling detection of early-stage changes that are poorly resolved using conventional methods.

In this work, we demonstrate the feasibility of a non-collinear parametric wave-mixing technique for in vivo sensing of human bone status. To our knowledge, this represents the first application of non-collinear wave mixing for in vivo bone assessment. Experimental results show good agreement with theoretical predictions, confirming the sensitivity of the approach to early structural changes. A theoretical framework is further presented to guide optimisation of the sensing configuration, supporting the development of quantitative nonlinear ultrasonic methods for early diagnosis and monitoring of osteoporosis.

003**Musculoskeletal Biomechanics I: gait, joints and motion****Thursday 3 September 2026** · 10:20-11:20 · Space Six**Chairs:** Professor Karl Bates · Dr James Charles

THE REPRODUCIBILITY OF MARKER-BASED MOTION CAPTURE FOR MOUSE HINDLIMB KINEMATICS DURING TROTTING

Dr Thomas Valerio, Dr Hector Arredondo, Dr Tegid Watkin, Professor Enrico Dall'Ara

Scheduled presenter: Dr Thomas Valerio · **Organisation:** University of Sheffield · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 18

DESCRIPTION OF PROPOSED TALK

Introduction

Quantifying gait patterns in mice is essential to assess the effects of experimental interventions for neuro-musculo-skeletal diseases. However, the small size of mice limits the ability to clearly visualise anatomical segments and compute joint angles. Marker-based motion capture is considered one of the most accurate techniques for estimating three-dimensional marker trajectories over time, but its implementation in mice is challenging, especially to achieve reproducible markers placement, keeping a minimum distance between markers to avoid tracking errors. The objective of this pilot study was to evaluate the reproducibility of a marker-based motion-capture protocol for analysing the kinematics of the mouse hindlimbs during trotting.

Method

We developed a customised experimental setup adapted from procedures previously established for rats [1]. Under anaesthesia, five 3D-printed reflective markers (1 mm diameter) were placed on both hindlimbs of three C57BL/6 female mice at weeks 20, 21, and 22 of age. For each limb, markers were positioned on the iliac crest, hip joint, knee joint, ankle joint, and metatarsal joint. Each anatomical landmark was palpated, and the corresponding marker was attached to the skin using a dedicated adhesive. After recovery (≥ 5 min), mice were positioned between two fixed Plexiglas panels and encouraged to trot by placing food rewards at both ends of the apparatus. Marker positions were recorded using a six-camera Vicon system at a sampling frequency of 200 Hz. Gait cycles were considered valid when the trotting speed was ≥ 0.25 m/s [2] and all markers were clearly visible in the post-processing software. Hip, knee, and ankle flexion angles, as well as hip abduction angles, were calculated from the marker coordinates for each gait cycle. Cycle-to-cycle variability was assessed by computing the coefficient of variation for each joint angle. Joint angles between right and left hindlimbs and between weeks 20, 21, and 22 were compared using statistical parametric mapping (SPM) [3].

Results

The coefficient of variation was $2.7 \pm 0.5\%$, $36.2 \pm 37.6\%$, $5.9 \pm 1.6\%$, and $7.6 \pm 2.6\%$ for the hip flexion, hip abduction, knee flexion, and ankle flexion respectively (mean $\pm$ SD calculated among mice and cycles, for each time point and side). Significant differences between limb sides were found between 0 and 22% of the stance phase only for the hip joint flexion.

Discussion

The marker-based motion capture technique showed good reproducibility for hip, knee, and ankle flexion angles, but not for hip abduction. Hip flexion and abduction appeared to be more sensitive to marker placement.

003**Musculoskeletal Biomechanics I: gait, joints and motion****Thursday 3 September 2026** · 10:20-11:20 · Space Six**Chairs:** Professor Karl Bates · Dr James Charles

Multi-Modal Ankle-Foot Sensor Fusion for Simultaneous Gait Event Detection and Terrain Classification

Mrs Hadeer Al-abboodi, Prof Abbas Dehghani-Sanij, Prof Shane Xie, Prof Rory O'Connor, Dr John Mitchell

Scheduled presenter: Mrs Hadeer Al-abboodi · **Organisation:** University of Leeds · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 74

DESCRIPTION OF PROPOSED TALK

Systems that can reproduce the biomechanical depth of laboratory motion capture while functioning outside of supervised conditions are necessary for accurate, real-world gait assessment. Existing wearable techniques fail to accomplish this goal because they only record a portion of the gait and do not have the contextual awareness required to assess mobility risk across a variety of real-world terrains. It has been demonstrated that the walking surface has a major impact on spatiotemporal gait parameters, like foot clearance, cadence, and step length. In this work, we present a novel bilateral ankle-foot wearable that integrates four combined sensor technologies: an IMU located at the foot for inertial gait assessment, a sixteen-channel pressure insole for ground-based force estimation, a LiDAR sensor at the lateral ankle (15 cm above ground) for foot clearance prediction, and a colour sensor placed at the heel position (5 mm from the ground) for walking terrain recognition. Combining these components forms a single, compact device that can categorise walking terrain while also extracting biomechanical gait events in real-world circumstances.

To validate the proposed device against the Vicon motion capture system, 53 walking sessions from 10 subjects were used. Pressure-insole rising edges were used to detect heel strike, LiDAR distance levels were used to establish the toe-off point, and IMU impact peaks were used as an automated backup. By maintaining accurate gait event identification with bilateral toe-off coverage in 100% of sessions and detection across five distinct sensor-failure profiles without session termination, the integrated system demonstrated its resilience for practical and clinical use.

Leave-one-session-out cross-validation was used to assess terrain classification over six terrain types. Carpet, grass, and laminate floors were all recognised with 100% accuracy using a nearest-centroid classifier that used colour, ambient brightness, stance-phase IMU RMS, and LiDAR-derived foot clearance statistics. This resulted in an overall accuracy of 80.6% (compared to 22% using colour alone). Each sensor's crucial and essential role in creating a contextually aware gait profile is confirmed by the stepwise accuracy advancement across modalities. These outcomes show that the ankle-foot sensor fusion system could mimic important outputs of laboratory motion capture in real-world settings by simultaneously extracting gait characteristics and terrain context. This foot unit is a component of a larger multi-node wearable architecture that is being developed for motion detection and fall prevention. Machine learning classifiers and full-body system validation will be implemented later in future work.

003**Musculoskeletal Biomechanics I: gait, joints and motion****Thursday 3 September 2026** · 10:20-11:20 · Space Six**Chairs:** Professor Karl Bates · Dr James Charles**Impact of task complexity on single-sensor gait parameters in Parkinson's disease and healthy adults**

Mr Daniel Nicoll, Susanna Margagaliotti, Dr Thomas Payne, Dr Ellen Buckley, Professor Oliver Bandmann, Dr Tecla Bonci

Scheduled presenter: Mr Daniel Nicoll · **Organisation:** University of Sheffield · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 88**DESCRIPTION OF PROPOSED TALK****Background**

Free-living gait monitoring using a single lower-back inertial measurement unit (IMU) offers significant potential to augment the clinical assessment of Parkinson's Disease (PD) through Digital Mobility Outcomes (DMOs) [1]. However, it remains to be established whether this approach can reliably estimate DMOs from in-clinic capacity tests that form the basis of current subjective clinical rating scales [2]. This study evaluates the accuracy of a single-IMU approach [3,4,5] against a multi-sensor reference system [6] across tasks with varying quantities of steady-state and complex gait.

Methods

8 Healthy Adults (HA, 70.6 ± 8.6 years) and 15 PD participants (64.8 ± 9.8 years, H&Y 1-3) performed three tasks ranging in complexity: a Timed Up and Go (TUG), 2x10m walk (10mW), and a 6-Minute Walk Test (6MWT) [7]. Concurrently detected walking bouts from the single-IMU and reference system were paired. Validation focused on mean stride duration (SD, s) and mean stride length (SL, m). Statistical agreement was assessed via Median Absolute Percentage Error (MAPE), bias, and Pearson's correlation (r).

Results

& Discussion: SD demonstrated excellent agreement during steady-state walking. In the 6MWT, SD showed exceptional accuracy with a MAPE of 0.8% (ranging 0.0-20%) $r = 0.91$ for PD and 1.5% (ranging 0.02-11%) $r = 0.98$ for HA. During the 6MWT, SL showed a significant negative bias, underestimating HA strides by 13 cm (MAPE 11.9%) and PD strides by 7 cm (MAPE 8.8%). Despite this offset, correlations remained high in steady-state tasks ($r > 0.91$). Notably, SL errors (8.8-15.3% across 10mW and 6MWT) were substantially lower than the ~26% error recently reported by Micó-Amigo et al. [4] using single-sensor real-world data. Furthermore, while they observed a positive bias (~12cm), our capacity tests yielded a consistent negative bias. The TUG, characterised by high transitional and curvilinear movement, exhibited the highest error magnitudes (e.g., HA SD MAPE 16.1%).

Conclusions

Single-sensors provide highly reliable temporal gait metrics. However, spatial metrics remain highly sensitive to task complexity. The systematic underestimation of stride length in our capacity tests - diverging from the overestimations and higher relative errors observed in free-living literature [4] - suggests that SL accuracy is heavily context-dependent. Increased transitional and curvilinear gait significantly reduces validity. These findings highlight the necessity of task-context integration and gait segmentation when extracting DMOs from short-duration clinical capacity tests. Future work will investigate stride-level error propagation to develop refined recommendations for extracting accurate DMOs from capacity tests towards a standardised approach.

003**Musculoskeletal Biomechanics I: gait, joints and motion****Thursday 3 September 2026** · 10:20-11:20 · Space Six**Chairs:** Professor Karl Bates · Dr James Charles

A Virtual Reality Platform for Assessing Human Motor Learning and Adaptation in a Pointing Task

Miss Christine Wood, Mr Max Thomson, Dr Henrik Gollee

Scheduled presenter: Miss Christine Wood · **Organisation:** University of Glasgow · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 96

DESCRIPTION OF PROPOSED TALK

Understanding how humans adapt their motor behaviour to changes in their environment is important for the development of computational models that can inform rehabilitation technologies and engineering systems [1]. While physical setups provide realistic environments, virtual reality (VR) systems offer opportunities to implement flexible and cost-effective experimental tasks. However, there has been limited work validating the accuracy and suitability of VR systems in this context [2,3]. This work investigates the use of a VR platform to assess human motor learning and adaptation in a manual pointing task.

A VR-based experimental platform was developed on the Meta Quest 3 and validated against a marker-based motion capture system (24 OptiTrack Flex3 Cameras). Positional error between the two systems was evaluated along three axes (lateral, vertical, and longitudinal) with respect to distance from the headset and instantaneous hand velocity. Results showed that positional error was below 1 cm near the centre of the tracking volume, but tracking accuracy was not uniform across the full tracking volume. Error increased with distance from the headset and with hand velocity, and reduced accuracy was observed near the limits of the effective tracking range.

Following validation, the experimental design was refined within the VR platform to minimise tracking error. The refined platform was then used to investigate human motor learning and adaptation. 23 participants completed a manual pointing task across two sessions on consecutive days, requiring them to reach and hit a target volume with their index finger. The task involved visuomotor gain perturbations, i.e. the mapping between the actual finger movement and the apparent movement in the VR environment varied, leading to behavioural adaptation by the participants. Kinematic and behavioural features were extracted to quantify changes in movement smoothness, corrective behaviour, and overshoot during learning and adaptation.

Experimental results show statistically significant reductions in corrective movements and overshoot from initial to later movements within blocks, as well as improved performance in the 2nd session. This indicates within-block learning and retention of learned behaviour across sessions, consistent with established findings from traditional experimental setups [4,5].

This work shows that, while VR headset-based hand tracking does not match the accuracy of marker-based motion capture systems, it provides sufficient accuracy to capture meaningful changes in motor behaviour. This supports the use of VR as a practical and scalable tool for studying human motor learning and adaptation, making it suitable for use in subsequent computational modelling.

003**Musculoskeletal Biomechanics I: gait, joints and motion****Thursday 3 September 2026** · 10:20-11:20 · Space Six**Chairs:** Professor Karl Bates · Dr James Charles**Design, development, and initial validation of a cadaveric gait simulator**

Miss Alix Hudson, Mr Matthew Duffy, Dr Kristiaan D'Août, Dr Sebastiano Fichera, Mr Lyndon Mason, Dr Alistair Bond

Scheduled presenter: Miss Alix Hudson · **Organisation:** University of Liverpool · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 117**DESCRIPTION OF PROPOSED TALK**

Cadaveric gait simulation is a technique that involves subjecting cadaveric feet to mechanical simulation and reproduction of in vivo forces to investigate foot and ankle biomechanics. Within the published literature there are thirteen institutions with a gait simulator, each unique in its design and applications owing to the specific research focus and the expertise of the multidisciplinary team involved. Constructing a cadaveric gait simulator often requires long periods of development and validation before it can be used to reliably assess joint kinematics and kinetics, limiting the accessibility of gait simulators for those wanting to explore new avenues of intrinsic foot biomechanics.

We have developed our own custom-built cadaveric gait simulator that utilises a six degree-of-freedom Stewart platform to act as the ground, moving about the fixed tibia to reproduce the motion of gait. The forces of nine extrinsic muscles are applied by actuators and transmitted through their tendons, whilst real-time ground reaction forces are collected by a force plate. Joint motion data will be collected through biplanar x-ray. Whilst the immediate focus is to reproduce foot and ankle kinematics, the simulator is designed to have a wide scope of applications and will enable investigation into the functional role of structures and their impact on joint kinematics and kinetics through invasive interventions that are unethical in vivo.

Quantifying joint kinematics using biplanar x-ray is a critical component of the simulator design, allowing for bone motions to be analysed using x-ray reconstruction of moving morphology. Alternative methods to track bone motions include skin surface markers. These are limited in their ability to obtain individual bone movements, and their accuracy is affected by skin motion artefacts. Also, previous studies that have used biplanar x-rays have reported challenges with the foot exiting the field of view in the later part of stance phase of gait. Utilising a Stewart platform in our design allows reproduction of gait whilst keeping the foot within the field of view and improving accuracy.

To ensure that the simulator can achieve reliable and accurate reproduction of in vivo kinematics, staged validation testing is required for each of the component parts of the simulator. This study details the initial trialling of the Stewart platform using inputs from in vivo walking trials to reproduce gait on a model foot and ankle whilst concurrently developing software that will integrate and coordinate the different elements of the simulator.

003**Musculoskeletal Biomechanics I: gait, joints and motion****Thursday 3 September 2026** · 10:20-11:20 · Space Six**Chairs:** Professor Karl Bates · Dr James Charles

Automatic Bone Tracking in Biplane Videoradiography: Validation Against RSA

Miss Janine Flohr, Dr Lauren Swain, Dr Petra Bonacic Bartolin, Prof Andrew Amis, Dr Richard van Arkel, Prof Cathy Holt, Dr David Williams

Scheduled presenter: Miss Janine Flohr · **Organisation:** Cardiff University · **Programme slot:** 11:10-11:20 · **Order:** 6 · **Paper:** 208

DESCRIPTION OF PROPOSED TALK

Introduction

Biplane videoradiography (BVR) is used to accurately calculate bone poses during dynamic motion. Autotrack, developed by University of Denver (DU), automates bone pose calculation by registering 3D bone geometries to pairs of radiographs [1]. A convolutional neural network (CNN) segments the radiographs and annotates key points; a template bone is optimised to the key points to be used as an initial pose estimation, and then a subject-specific bone is optimised using the segmentation. This study aimed to assess the accuracy of Autotrack with images from our own bespoke BVR system by comparing the derived bone poses to those obtained using Roentgen stereophotogrammetric analysis (RSA).

Methods

Four cadaver legs sourced from Medcure Body Donation were transected through the femoral and tibial diaphysis and implanted with 2mm radiopaque steel beads (minimum four per bone). The cadavers were mounted in a rig that cyclically moved the knee through approximately 20-80° flexion at 1.2 rotations-per-second, unconstrained in all degrees of freedom (DOFs). Over 6,000 frames of BVR data were collected, across multiple cadavers and various camera setups. This preliminary analysis focused on femur tracking during one rotation cycle of a single trial (84 frames). One camera approximately captured the sagittal plane and the other approximately captured coronal plane, to emulate our in-vivo level treadmill gait setup. RSA was performed using XMAlab [2]. The beads were digitally removed from the radiograph (Matlab, Mathworks) and bone poses were calculated using Autotrack [1]. Bone poses were filtered using an adaptive low-pass Butterworth filter and mean absolute error (MAE) was calculated for each DOF.

Results and discussion

The MAEs for the rotational DOFs were 0.33° (x), 0.29° (y), and 0.84° (z). For translation, the MAE values were 0.47 mm (x), 0.75 mm (y), and 0.64 mm (z). Generally, these results were higher than a previous DU validation study, which reported MAEs of <0.4° and ≤0.6mm across all DOFs. The discrepancy likely arises from differences in setups between the studies, with DU using a static phantom with minimal soft tissue set to full extension and both X-ray cameras imaging the sagittal plane. As Autotrack was trained with data only collected in the DU configuration, it may have performed more poorly with our data due to imaging in a different setup. Future work will explore retraining of the CNN to include radiographs in different planes and expand to assessing Autotrack against RSA for further cadavers and camera angles.

004**Orthopaedic, Dental and Prosthetic Engineering****Thursday 3 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Dr Rosti Readioff · Professor Anthony Bull

Personalised Neck Collars: A Digital Workflow for Scan-to-3D-Printed Orthoses. Design and Evaluation vs Standard Collars.

Miss Silvana Skotiniyadis, Angus B. Clark, Anthony Bull, Louis J. Koizia, Michael B. Fertleman

Scheduled presenter: Miss Silvana Skotiniyadis · **Organisation:** Imperial College London · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 11

DESCRIPTION OF PROPOSED TALK

Background

Rigid cervical collars are widely used in trauma settings following cervical spine fractures or post-operatively [1]. They are commonly associated with complications such as pain, swallowing difficulties, and pressure ulcers [2]. Advances in additive manufacturing have enabled the design of personalised collars tailored to individual patient anatomy, potentially improving comfort and clinical performance [3]. This study aimed to evaluate the feasibility of a digital workflow where neck scans are converted into computer-aided design (CAD) models for 3D-printed personalised collars, and to compare their performance with standard off-the shelf collars.

Methods

Ethical approval for this study was obtained from the institution's Research Ethics Committee. Four healthy volunteers (2 male, 2 female) were recruited. A handheld scanner (EINSTAR, Shining 3D, Hangzhou, China) was used to capture the anatomical surface of each participant's neck. The resulting 3D meshes were processed and edited using MeshLab, personalised collars were then designed using Autodesk Meshmixer and 3D-printed in Polylactic Acid (PLA) via Fused Filament Fabrication. Each participant completed two test sessions: one with a standard rigid collar (Miami J) and one with a personalised 3D-printed collar, with order counterbalanced across participants. Each collar was worn for four hours, after which neck range of motion in all primary axes was measured with a digital goniometer. Participants rated their comfort on a visual analogue scale (VAS) and swallowing function using the Eating Assessment Tool (EAT-10). Following collar removal, skin integrity was inspected, with any markings photographed and documented.

Results

& Discussion: Personalised collars restricted flexion and extension more effectively than standard collars across all participants, reducing mean flexion by 3.7° and extension by 8.7°. Discomfort scores decreased in two participants and were unchanged in the remainder. Swallowing outcomes and skin responses were mixed across participants. These results demonstrate the feasibility of a scan-to-3D-printed personalised collar workflow. Personalised collars may offer improved cervical immobilisation and reduced discomfort, the latter potentially supporting greater patient adherence to collar prescription.

Conclusion

This pilot study demonstrates the feasibility of a digital scan-to-3D-printed workflow for personalised neck collars. Preliminary findings suggest potential benefits in immobilisation and comfort compared to standard collars. Further studies with larger cohorts are required to determine clinical significance.

004**Orthopaedic, Dental and Prosthetic Engineering****Thursday 3 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Dr Rosti Readioff · Professor Anthony Bull

Development of Physics-Augmented Neural Network Constitutive Models for the Meniscal Root in Mesh-Free Knee Joint Contact Simulation

Mr YuChun Chou, Dr Rosti Readioff, Dr Tsung-Hui Huang

Scheduled presenter: Mr YuChun Chou · **Organisation:** University of Liverpool · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 44

DESCRIPTION OF PROPOSED TALK

The meniscal root is a ligament like attachment that anchors the meniscus to the tibial plateau and plays a key role in maintaining hoop stress, distributing joint loads, and preserving knee stability. Injury or degeneration of the meniscal root alters joint mechanics, increases contact stress, and contributes to the progression of osteoarthritis [1]. Accurate constitutive modelling of this soft tissue is therefore important for biomechanical analysis and treatment planning. However, conventional hyperelastic constitutive laws coupled with empirical damage models often have difficulty reproducing the nonlinear, heterogeneous, and progressive softening behaviour observed experimentally. To address these challenges, this work develops a physics augmented neural network constitutive framework for modelling the meniscal root under large deformation and contact loading. A constitutive artificial neural network (CANN) [2] is used to represent the hyperelastic response while preserving continuum mechanics structure and thermodynamic consistency. Progressive softening and failure are incorporated through a stage dependent model based neural network (MBNN), in which multiple damage regimes are automatically identified and the appropriate evolution law is selected from linear, power law, and exponential forms. Damage irreversibility is enforced to ensure physically admissible material degradation. To mitigate strain localization during softening, a phase field type regularization is introduced via a length scale dependent degradation function at the material point level. The constitutive model is implemented within a mesh free material point method (MPM) framework [3], allowing simulation of large deformation, evolving contact interfaces, and progressive damage evolution up to separation in complex knee geometries without mesh distortion. The framework is evaluated against benchmark soft tissue damage problems and knee joint contact simulations. The results show that the proposed model can reproduce key trends in contact pressure, peak contact stress, and damage evolution while maintaining numerical stability. The framework offers strong potential for future patient specific digital knee twins, improved surgical planning for meniscal root repair, and predictive assessment of osteoarthritis risk.

004**Orthopaedic, Dental and Prosthetic Engineering****Thursday 3 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Dr Rosti Readioff · Professor Anthony Bull

DEVELOPMENT AND VALIDATION OF A NUMERICAL MODEL OF BONE HEALING IN MANDIBULAR RECONSTRUCTION TO COMPARE SURGICAL RECONSTRUCTION STRATEGIES

Dr Camilla Gironi, Dr Federica Ruggiero, Dr Laura Cercenelli, Professor Silvia Schievano, Dr Fabrizio Neri, Professor Anna Maria Baietti, Professor Achille Tarsitano, Professor Emanuela Marcelli, Dr Alessandro Borghi

Scheduled presenter: Dr Alessandro Borghi · **Organisation:** Durham University · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 45

DESCRIPTION OF PROPOSED TALK

Mandibular reconstruction using fibular free flaps (FFF) is the gold standard following tumour resection, trauma, or infection; however, non-union rates remain as high as 20%, highlighting the need to optimise bone healing across intersegmental gaps [1-2]. Mechanical factors, particularly interfragmentary strain and fixation stability, play a critical role in early tissue differentiation and subsequent ossification [3-4]. This study presents a mechanobiological finite element (FE) framework to evaluate how different fixation strategies influence early-stage bone healing.

Patient-specific FE models were developed from postoperative CT data (n=2) and implemented in ANSYS. Two fixation configurations-reconstruction plates and miniplates-were applied to identical anatomical models to isolate the effects of fixation type [5-6]. Early healing conditions were simulated by introducing callus tissue at graft interfaces. Physiological masticatory loading conditions were applied, and a mechano-regulation algorithm incorporating a tissue differentiation model was used to predict the progression from granulation tissue to ossification. The algorithm evaluated local volumetric and distortional strains, iteratively updating material properties when osteogenic thresholds were met, following established mechanobiological principles [3,4].

Both fixation strategies provided sufficient mechanical stability, with stresses remaining below the yield strength of titanium. However, miniplates generated a more uniform strain distribution within the callus, maintaining mechanical stimuli within the predicted ossification window. This resulted in earlier and more extensive initiation of ossification compared to reconstruction plates, consistent with previous computational findings [7,8]. Model predictions were qualitatively validated against 17-month follow-up CT scans, where regions of increased radiodensity corresponded with areas predicted to ossify earlier [5].

This study represents one of the first clinically validated applications of a mechano-regulation algorithm for mandibular reconstruction. The findings suggest that, while both fixation systems are mechanically adequate, miniplates may create a more favourable mechanobiological environment for early bone healing. The proposed framework enables quantitative assessment of fixation strategies and provides mechanistic insight into the relationship between local mechanical conditions and tissue differentiation. This approach has the potential to support patient-specific surgical planning and improve clinical outcomes by optimising fixation design to enhance bone regeneration.

004**Orthopaedic, Dental and Prosthetic Engineering****Thursday 3 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Dr Rosti Readioff · Professor Anthony Bull**Biomechanical drivers of proximal joint degeneration after traumatic hindfoot injury: preliminary findings from the ADVANCE study**

Miss Clara Molano Gomez, Dr Caitlin Edgar, Gp Capt Alexander Bennett, Prof Anthony Bull

Scheduled presenter: Miss Clara Molano Gomez · **Organisation:** Imperial College London · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 159**DESCRIPTION OF PROPOSED TALK**

A signature injury of the recent conflict in Afghanistan is calcaneal fractures due to an underbody blast, resulting in high levels of disability and amputation(1, 2). ADVANCE study findings indicate military traumatic hindfoot injuries lead to secondary musculoskeletal outcomes comparable to transtibial amputation. As an integrated kinetic chain, altered foot and ankle biomechanics may drive compensatory loading that contributes to proximal joint degeneration(3, 4).

This research investigates the hypothesis that distal mechanical dysfunction following hindfoot trauma drives progressive proximal musculoskeletal degeneration. To address limitations of conventional 'rigid foot' gait analysis, we are developing a novel subject-specific multi-segment foot model in OpenSim. The model incorporates tri-planar motion across four foot joint complexes, enabling detailed analysis of injury-specific mechanics and their influence on whole-limb loading.

Participants were recruited from the ADVANCE study, investigating long-term outcomes of UK military personnel deployed to Afghanistan(5). Preliminary motion-capture data were collected from two participants with isolated hindfoot injuries, one using a passive dynamic ankle-foot orthosis, approximately 15 years post-injury and four healthy military controls for overground walking at self-selected speed.

Preliminary results revealed distinct compensatory strategies between injured participants. The unbraced participant demonstrated a failure of eccentric control, characterised by excessive mid-stance dorsiflexion and rapid pre-swing plantarflexion, triggering elevated knee extension moments. In contrast, the orthosis user exhibited restricted ankle ROM but knee kinetics comparable to controls, suggesting a protective mechanical effect. Both participants showed contralateral hip overextension and reduced flexion moments, an altered gait that could explain why the injured participants progressed to hip OA. Further planned analysis of joint reaction forces will provide insight.

While preliminary, this work establishes a critical foundation for ongoing data collection. Further planned data collection, alongside detailed analysis of inter-segment foot mechanics, is essential to confirm these findings and determine whether interventions can modify long-term musculoskeletal outcomes. In addition, inclined walking and stair climbing analysis will reveal whether the compensatory patterns observed during level walking are amplified during more demanding functional tasks. This work provides a new platform for understanding the mechanisms of long-term disability after severe hindfoot trauma and evaluating targeted interventions to improve outcomes.

004**Orthopaedic, Dental and Prosthetic Engineering****Thursday 3 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Dr Rosti Readioff · Professor Anthony Bull

Human in vitro systems to measure the effect of the chemical composition of human bone on its nanoscale mechanical properties and advance animal-free research.

Prof Elisa Budyn, Dr. Arnavaz 2 Hakimiyan, Mr. Romain Dupouy, Mr. Elias Aloaui-Chrifi, Ms. Shelby Prietro del Rivero, Dr. Christophe Sandt, Dr. James Williams, Dr. Susan Chubinskaya, Dr. Brian T. David

Scheduled presenter: Prof Elisa Budyn · **Organisation:** Ecole Normale Supérieure Paris-saclay · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 120

DESCRIPTION OF PROPOSED TALK

Aging pathologies affect human bone homeostasis, chemical composition, and mechanical properties. Human in vitro models offer new opportunities and provide a clinically relevant environment to understand how these properties are related to each other, which could lead to the identification of relevant biochemical biomarkers of aging as well as contribute to the characterization, treatment, and prevention of further bone damage in the elderly.

Nanoscale chemical characterization was possible using Optical Photothermal Infra-Red Spectroscopy (O-PTIR), a super-resolution infrared micro-spectroscopy technique, on millimeter-sized samples prepared from human cadaveric bones of different sexes, ages, and pathologies. Both explants and tissue samples, that were recut into prisms to prepare organoids from cadavers, were collected within 10 days of death and kept alive for four months before O-PTIR analysis. The prismatic samples were subsequently decellularized and re-seeded with adult human primary mesenchymal stem cells (MSCs) from different donors (of different ages and sexes) to create bone organoids. MSCs differentiated into stem cell-derived osteocytes within 30 days, then formed new bone tissue that was analyzed via O-PTIR. For control, some of the cadaveric samples were directly analyzed with O-PTIR after either collection or decellularization. Secondly, nanoscale mechanical characterization was performed using Finite Element Models (FEM) of the bone extracellular matrix (ECM), which was built from TEM morphological imaging to visualize the mechanical 3D stress field inside a volume of tissue approximating O-PTIR spatial resolution. The numerical model was fed with the material properties inferred based on O-PTIR measurements. AI-based k-means clustering identified sub-families among O-PTIR spectra and extracted variations in the chemical compositions, such as the relative contents of collagen, minerals, and fat, among donors of different age groups.

The fiber architecture was shown to lower the stresses in minerals and collagen and play a key role in redistributing the mechanical loads along the cell processes, peri-cellular matrix (PCM), and extra cellular matrix (ECM). The 45° fiber orientation decreased stresses in minerals, collagen, PCM and the cell processes, and slightly raised them in the ECM, compared to the 60° orientation. As both the collagen/mineral ratio and fat content tend to increase with age, the hypermineralized case was shown to increase stresses in minerals and the hyperlipidic case to decrease stresses in collagen, with no change in the ECM or cell processes. Finally, biomarker gene expression was measured via qPCR of the bone cells of the different age groups and was then correlated with the O-PTIR results.

004**Orthopaedic, Dental and Prosthetic Engineering****Thursday 3 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Dr Rosti Readioff · Professor Anthony Bull

Validation of an in-house patient-specific drill guide workflow for reverse shoulder arthroplasty: a two-piece Morse-taper design with cost and turnaround advantages over outsourced pathways

Mr Yazan Haidar, Mr Iain Hendry, Mrs Clodagh MacRae, Mr David Shields, Mr Robin Sayer

Scheduled presenter: Mr Yazan Haidar · **Organisation:** Nhs Ggc · **Programme slot:** 11:10-11:20 · **Order:** 6 · **Paper:** LB03

DESCRIPTION OF PROPOSED TALK

Background

Reverse shoulder arthroplasty outcomes depend on accurate glenoid component version and inclination. Patient-specific 3D printed guides improve component positioning [1, 2], and a single-centre series since 2019 reports significant improvement in glenoid inclination accuracy [3]. A 106-case NHS audit reported such guides changed the surgical plan in 37.7% of cases and reduced operating time in 41.5% [5]. Published in-house point-of-care programmes describe workflows for complex reconstructive surgery [6, 7], but report cost qualitatively; per-case micro-costing is still needed. Commercial PSI drill guide provision carries four-to-six week lead times [4]. We report an in-house workflow, quantified per-case, built around a two-piece Morse-taper guide adding a reusable metal drilling interface.

Methods

The workflow's patient CT, segmentation, CAD, desktop SLA printing in autoclavable biocompatible resin, post-processing, autoclave sterilisation, and intra-operative use, runs entirely in-house under an ISO 13485-certified QMS, with each guide manufactured as a custom-made medical device. The guide is a two-piece assembly: a patient-specific main body anchors on anatomy-conforming contact and locks rotationally against a defined glenoid landmark; a reusable metal pin sleeve engages via a Morse-taper interface, eliminating resin-debris at the drill contact and cutting consumable cost. Each step, timeframe, staff role and cost was audited in the reverse shoulder pilot.

Results

The pilot delivered an all-in per-case cost of ~£500 (£125 consumables, £150 labour, £196 fixed equipment overhead), including engineer-led segmentation and CAD. This is comparable to £460-£500 per case for equivalent outsourced guides observed across two major orthopaedic vendors' NHS procurement ledgers; the in-house figure carries a downward trajectory as fixed overhead amortises across a routine caseload. In-house also wins on scope: outsourced provision uses automated segmentation of lower fidelity and pushes design into vendor software operated by the surgeon, converting planning into unpaid surgeon time, whereas the in-house workflow retains expert segmentation and design within the engineering service. End-to-end turnaround was three to five working days against four-to-six weeks typical of outsourced pathways [4]. A small in-patient series is planned as the bridge to routine clinical use.

Conclusion

A fully in-house 3D printed PSI drill guide combining a disposable patient-specific main body with a reusable Morse-taper pin sleeve is cost-comparable to outsourced provision at pilot scale, with lower unit cost projected at routine throughput, structurally faster in turnaround, and keeps expert segmentation and CAD inside the service rather than offloading design onto surgeons; per-case costs are quantitative rather than qualitative.

005**Metamaterials for Health****Thursday 3 September 2026** · 10:20-11:20 · Wolfson Lecture Theatre**Chairs:** Dr Tom Allen · Mr Adam Weston

Development of a Female-Specific Lower Limb Surrogate for Inclusive Knee Brace Design and Evaluation

Dr Tasneem Sabir, Dr Tom Allen, Dr Elisa Roldan Ciudad

Scheduled presenter: Dr Tasneem Sabir · **Organisation:** Manchester Metropolitan University · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 16

DESCRIPTION OF PROPOSED TALK

Knee injuries occur at significantly higher rates in females than males, particularly ligament injuries, and knee braces are widely prescribed to support stability, rehabilitation, and return to activity. However, many female users report poor fit, discomfort, and brace migration, which can limit effectiveness and reduce compliance during recovery. These issues are rooted in design and preclinical testing practices that rely predominantly on male anthropometric data and simplified limb models that do not represent female lower limb anatomy or soft tissue mechanics. This study addresses this unmet need through the development and validation of a novel, female specific lower limb surrogate to enable inclusive and biomechanically representative knee brace testing.

A 50th percentile female lower limb surrogate was designed using population-based anthropometric data and fabricated via additive manufacturing. The surrogate incorporated anatomically representative geometry and a compliant soft tissue layer designed to replicate female skin and subcutaneous tissue behaviour. Three candidate materials-thermoplastic polyurethane (TPU), thermoplastic elastomer (TPE), and TPU powder-were evaluated for soft tissue simulation. Mechanical characterisation was conducted to quantify Shore A hardness, elastic modulus in compression, and Young's modulus in tension, capturing deformation and interfacial behaviour relevant to brace-skin interaction during movement.

Among the tested materials, TPU powder demonstrated the closest agreement with reported female biological soft tissue properties and was therefore selected for integration into the final surrogate. The completed model enabled repeatable evaluation of knee brace performance, including flexion and extension range, brace migration, fit consistency, and identification of pressure-prone regions requiring design improvement. Compared to conventional stiff or male-derived test models, the surrogate provided enhanced biomechanical realism and sensitivity to female-specific fit and compliance effects.

This work introduces the first additively manufactured, mechanically validated female lower limb surrogate specifically designed for knee brace evaluation. Scientifically, it advances physical modelling approaches by embedding sex-specific mechanics into orthopaedic device testing. Translationally, it provides an industry-relevant platform to support inclusive brace design, reduce late-stage design revisions, and improve rehabilitation outcomes for an underrepresented patient population. The surrogate establishes a scalable pathway towards more equitable and standardised evaluation of wearable orthopaedic devices.

005**Metamaterials for Health****Thursday 3 September 2026** · 10:20-11:20 · Wolfson Lecture Theatre**Chairs:** Dr Tom Allen · Mr Adam Weston

Reducing MRI Artefact Susceptibility Using Additively Manufactured Porous Titanium Implants: A Cranioplasty Case Study.

Mr Fares El-dessouky

Scheduled presenter: Mr Fares El-dessouky · **Organisation:** University of Birmingham · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 27

DESCRIPTION OF PROPOSED TALK

Titanium implants are considered MRI-safe, yet the paramagnetic nature of Ti-6Al-4V (Ti-64) generated magnetic susceptibility artefacts that can significantly degrade image quality, obscure critical anatomy and mask post-operative complications such as microbleeds, infection and tumour recurrence [1, 2]. This effect is compounded at higher field strengths and with susceptibility sensitive sequences such as fast gradient echo imaging. Despite this disadvantage, Ti-64 is still considered the preferred material for skeletal reconstruction due to its exceptional mechanical properties, biocompatibility and low infection rates [3, 4].

Additive manufacturing enables fabrication of complex lattice architectures in Ti-64 [5, 6], offering a novel design-led strategy to reduce bulk magnetic susceptibility through controlled porosity, without reliance on sequence modification. Six specimens were evaluated: a solid Ti-64 control, a perforated plate representing current clinical practice, and four metamaterial lattice designs (Honeycomb, Gyroid, Volumetric Dual and Volumetric Edge). MRI artefact volumes were quantified across all specimens using a standardised phantom protocol.

Introducing metamaterial lattice porosity reduced artefact volume by approximately 40%, corresponding to a 46% increase in porosity relative to the solid control. Critically, mechanical integrity was maintained across all lattice configurations. These findings demonstrate that metamaterial implant geometry can be leveraged as a novel design parameter to improve MRI compatibility, offering a pathway to more diagnostically reliable post-operative imaging and ultimately greater confidence in clinical decision making for patients with metallic implants.

005**Metamaterials for Health****Thursday 3 September 2026** · 10:20-11:20 · Wolfson Lecture Theatre**Chairs:** Dr Tom Allen · Mr Adam Weston

Exploration of Bio-inspired, Functionally Gradient Composites with Optimized Mechanical Properties

Mr Haydn Whitehouse-Iloyd, Dr Riaz Akhtar, Professor Po-Yu Chen

Scheduled presenter: Mr Haydn Whitehouse-Iloyd · **Organisation:** University of Liverpool · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 41

DESCRIPTION OF PROPOSED TALK

Functionally Gradient Materials (FGMs) are composites which express graded, smooth interfaces between components. This removes the most likely point of failure at the interface between components, creating mechanical heterogeneity for application in unique environments. The interfacial tissues which connect Flight Feathers in volatile birds to the wing, both anchoring and transferring aerodynamic and mechanical forces onto the skeleton during flight, are relatively unexplored within scientific literature and could potentially express a functional graded structure. Histology and Micro-CT were used to visualise the interfacial tissues. Sections of the wing were dissected between the elbow and the wrist. Histological samples were fixed in 10% NBF, softened with Formalic acid, embedded in wax for sectioning and stained with Verhoeff's Van Gieson and Masson Trichrome for Elastic Fibres and Collagen respectively. Micro-CT samples were stained with Lugol's Iodine and scanned with a Zeiss Xradia Versa 620 X-ray microscope. Oscillatory Nanoindentation measured the elastic nature of the wing tissue from posterior to anterior. Tensile testing measured the force required to remove feathers from the wing. Samples were dehydrated in an ethanol series and the anterior sections embedded in Epoxy resin. Samples were tested on a single column Instron with a 1000 N load cell at a rate of 1mm/min. Visualisation of the tissue revealed fibrous appearing structures, associating between the feather shaft, skeleton and muscular tissue. Histological images show structures replete in elastic fibres branching from muscular tissue towards the feather shaft and intersecting through a Collagenous interface. Nanoindentation reported a decrease in $\tan\delta$ (ratio of the loss modulus- G'' , to storage modulus- G') moving anteriorly. Average Feather Pull-out load was 34.17 N and average extension at failure was 2.54mm. The data shows the interfacial tissue with a fibrous appearance containing structures rich with elastic fibres interacting between the feather shaft and greater anatomy of the wing. Mechanical data implies the structure of the wing becoming more elastic moving away from the feather shafts. Extension and load data suggest the interfacial tissue can stretch and stiffen with uniaxial loading until failure. Analysing this data in the context of single fibre pull-out tests produces an average Interfacial Shear Strength of 0.27 MPa. These data sets are to be used in the future as a reference for design and manufacturing of a Bioinspired FGM based of the interfacial tissues associated with the Flight Feathers.

005**Metamaterials for Health****Thursday 3 September 2026** · 10:20-11:20 · Wolfson Lecture Theatre**Chairs:** Dr Tom Allen · Mr Adam Weston

A Biomimetically Inspired Collagen Scaffold with Graduated Pore Structure for Meniscal Repair

Mr Yizhuo Wang, Dr Jenny Shepherd

Scheduled presenter: Mr Yizhuo Wang · **Organisation:** University of Leicester · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 52

DESCRIPTION OF PROPOSED TALK

Introduction

Meniscal tears affect 60-70 per 100,000 individuals annually, leading to pain, instability, and progressive joint degeneration¹. Although tissue engineering offers promising strategies for meniscal regeneration², the limited self-healing capacity of the meniscus, particularly in avascular regions, remains a major challenge³.

This study aims to develop a biomimetic collagen scaffold with a graduated pore structure and fibre reinforcement, and to evaluate its performance through mechanical testing, degradation analysis, and in vitro cell culture.

Materials and Methods

Type I collagen slurry was iteratively layered in a freeze-dryer at pre-freeze temperatures of -20°C and -40°C to generate a graduated pore architecture. Cross-linked collagen fibres extruded in PEG/PBS buffer and electrospun gelatine fibres were incorporated to enhance structural integrity. EDC/NHS cross-linking was applied post-freezing.

Scaffolds were characterised using scanning electron microscopy (SEM), micro-computed tomography (micro-CT), and mechanical testing. For biological evaluation and as part of a wider study, sterilised scaffolds were seeded with tenocytes at a density of 1×10^4 cells per scaffold. Cell viability (Live/Dead assay), proliferation (alamarBlue), morphology, and infiltration (confocal microscopy) were assessed at days 1, 3, and 7.

Results

The scaffold exhibited distinct regional variations in pore size and interconnectivity, with seamless integration between layers. The -40 °C layer showed finer, more homogeneous pores, whereas the -20 °C layer presented larger, more open structures. Collagen fibre incorporation formed a reinforcing network, enhancing both structural integrity and porosity.

Degradation studies indicated a controlled and gradual reduction in mass and mechanical properties over time. Cell culture results showed robust cell attachment and sustained viability over 7 days, with increasing metabolic activity indicating active proliferation. Confocal imaging revealed elongated cell morphology aligned along collagen fibres, suggesting contact guidance and fibre-directed cell organisation.

Conclusion

The developed scaffold successfully combines a graduated pore structure with fibre reinforcement to achieve enhanced mechanical performance and controlled degradation behaviour. It supports cell viability, proliferation, and alignment, demonstrating strong potential for guiding tissue regeneration in meniscal repair.

005**Metamaterials for Health****Thursday 3 September 2026** · 10:20-11:20 · Wolfson Lecture Theatre**Chairs:** Dr Tom Allen · Mr Adam Weston

Harnessing Piezoelectric Auxetic Metamaterial Architectures for Cardiac Tissue Engineering

Mr Luís Nascimento, Priscila Melo, Paula Marques, André Pereira, Gavin Richardson, Nathalie Barroca

Scheduled presenter: Mr Luís Nascimento · **Organisation:** Universidade De Aveiro · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 71

DESCRIPTION OF PROPOSED TALK

Despite decades of advances into cardiac patch development, the clinical “gold standard” remains elusive. Current patches mainly provide passive mechanical support, failing to mimic the fundamental nature of the myocardium: a synchronized, electrically and mechanically active tissue. Statistics remain grim, with heart failure mortality post-myocardial infarction at ~18.8% [1]. The bottleneck of the field is not just mechanical, but functional with current patches creating a “conductive mismatch” that disrupts natural signaling and carry the risk of arrhythmias. To envision the regeneration of the ischemic heart, a scaffold must do more than hold tissue together, it must harness the heart’s inherently dynamic mechanical environment [2], [3]. This is where piezoelectric materials become relevant. Piezopolymers like poly (L-lactic acid) (PLLA) have long been proposed as a potentially relevant material [4], yet the polymer mechanical profile is not completely suitable for the beating heart. The present work breaks that stalemate by being the first to merge metamaterial architecture with a near-field electrospinning technology, moving beyond traditional 2D mats into 3D-architected scaffolds that offer piezoelectric actuation and physiological compliance.

Herein, we engineered bow-tie auxetic geometries (40° and 60° angle) and compared them against a non-auxetic (N.A.) design. Mechanical characterization revealed that geometry significantly influences scaffold performance. While the N.A. structures exhibited a limited elastic regime, similar to traditional PLLA electrospun mats (approximately 5% strain; 5 min/min), the auxetic architectures demonstrated an architecture engineered elastic response of up to 20% strain, a critical range that encompasses the physiological deformation of the heart (10 - 15%). Although cyclic stretching indicated fatigue in early cycles due to the micro fibrous nature of the struts, the auxetic designs still outperformed N.A durability. Additionally, impact testing hints that geometry influences electromechanical output, with 60A structures producing superior power output under impact. Preliminary biological assays using HL-1 cardiomyocytes confirmed that while geometry affects initial cellular attachment via surface area variations, it does not yield significant differences in terms of maturation or spontaneous beating capacity.

This work challenges the idea of passive cardiac engineering by providing a scalable, tunable manufacturing route for active scaffolds, advancing towards medical devices that do not only shield the heart but actively actuate on it. Future research will explore the potential of this piezoelectric stimulation to impact cellular senescence in human AC16 cells, paving the way for a new generation of bio-instructive implants that address the global economic and physical burden of heart failure.

005**Metamaterials for Health****Thursday 3 September 2026** · 10:20-11:20 · Wolfson Lecture Theatre**Chairs:** Dr Tom Allen · Mr Adam Weston

Optimising additively manufactured mechanical metamaterials for linear and angular head-impact protection

Mr Harry Plant

Scheduled presenter: Mr Harry Plant · **Organisation:** Sheffield Hallam University · **Programme slot:** 11:10-11:20 · **Order:** 6 · **Paper:** 239

DESCRIPTION OF PROPOSED TALK

Traumatic brain injury is a major concern in sports involving falls and collisions. Conventional helmets typically use expanded polystyrene (EPS) liners to reduce translational head acceleration, but real-world impacts are often oblique and generate both linear and rotational motion. This creates a need for helmet liners that can be optimised for multiple impact modes.

This study investigates whether an additively manufactured anti-tetra chiral mechanical metamaterial could provide a tunable alternative to EPS for sports head impact protection. The initial objective was to minimise peak linear acceleration (PLA) and establish a methodology that can subsequently be expanded to angular-impact performance. Snowsports was used as the case study.

Anti-tetra chiral lattice specimens, 30 mm in height, were manufactured from TPU 95A. Beam length, beam thickness and central-ring diameter were varied at four levels using a Taguchi orthogonal array, reducing the experimental requirement from 256 to 16 designs. Specimens were physically tested on a drop rig at 3 impact velocities seen in snowsports. The identified design was manufactured and compared with equivalent thickness EPS specimens using acceleration-time data and peak responses.

The optimised structure used a beam length of 3.75 mm and beam thickness of 2.00 mm, while central-ring diameter had comparatively little influence on the response. The optimum design betters the EPS with an average reduction in PLA across the 3 velocities of 56.4%

These findings demonstrate the potential of architected lattice structures to reduce response at varying impact energies. Future work will expand the design space and use a Gaussian-process surrogate model with a genetic algorithm to reduce physical testing. Oblique impact testing will then quantify angular acceleration and velocity, enabling multi-objective optimisation of linear and rotational protection before full-helmet validation

006**AI in Bioengineering I: imaging, sensing and predictive analytics****Thursday 3 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk**Multimodal Deep Learning Integration of ECG Variables, and Clinical Factors for Risk Prediction in a Global Coronary Heart Disease Cohort: Insights from the INTERASPIRE Study**

Mr Qinkai Yu, Dr Yanda Meng, Professor Yalin Zheng, Professor David Wood, Professor Gregory Lip

Scheduled presenter: Mr Qinkai Yu · **Organisation:** University of Liverpool · **Programme slot:** 13:00-13:10 · **Order:** 1 · **Paper:** 147**DESCRIPTION OF PROPOSED TALK****Background**

Risk stratification in patients with coronary heart disease (CHD) relies primarily on clinical characteristics, yet electrocardiography (ECG) provides important diagnostic and prognostic information. While individual ECG abnormalities are associated with adverse outcomes, the incremental prognostic value of combining Deep Learning (DL)-derived ECG image-based features ('DL ECG-biomarkers') beyond clinical predictors remains uncertain. We aimed to evaluate whether incorporating DL-ECG information improves prediction of one-year outcomes in a large multinational CHD cohort.

Methods

We analyzed 3,696 patients (mean age 59.8, SD 10.3; 20.5% female) from the 14-country INTERASPIRE study. The primary endpoint was a 4-component composite (all-cause death, hospitalizations for acute myocardial infarction, heart failure, or stroke). We developed and evaluated three tiers of predictive models: (1) 'Clinical factor only' baseline models utilizing 15 clinical variables (including demographic characteristics, prior cardiovascular disease and other relevant comorbidities), (2) 'Clinical-ECG' variable models combining clinical factor variables with 13 ECG variables (including conduction intervals, left ventricular hypertrophy, and ischemic changes), and (3) a novel multimodal deep learning (DL) model that integrates both clinical factor covariates, Clinical ECG variables and scanned DL-ECG biomarker images. The dataset was split 1:1 into training and testing sets.

Results

In the test set, the addition of detailed 'Clinical-ECG' variables to standard clinical covariates enhanced the predictive performance of traditional ML architectures compared to clinical-only baselines (e.g., Random Forest AUC improved from 0.660 [95% CI 0.602-0.726] to 0.666 [95% CI 0.605-0.727]). The multimodal DL model incorporating scanned DL-ECG biomarker images achieved the highest discriminative ability, outperforming all other approaches with an AUC of 0.726 (95% CI 0.670-0.782). This multimodal approach proved superior to both the best-performing clinical factor-only baseline (AUC=0.709 [95% CI 0.652-0.769]) and the combined Clinical factor and Clinical-ECG variable models (AUC=0.702 [95% CI 0.647-0.756]), demonstrating the powerful incremental value of deep representation learning on ECG images. Detailed performance comparisons are illustrated in Figure 1 and Figure 2.

Conclusion

In this high-risk CHD cohort, a multimodal DL model leveraging raw ECG images ('DL ECG biomarkers') alongside structured clinical factor and clinical-ECG variables provides the most robust risk stratification. Integrating advanced AI-driven image analysis with traditional clinical metrics yields significant prognostic insights, outperforming standard clinical risk models.

006**AI in Bioengineering I: imaging, sensing and predictive analytics****Thursday 3 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

Co-design and Implementation of FatigueSense: A Wearable-Integrated AI Mobile Health Platform for Personalized Post-COVID Fatigue Management

Mr Nana Yaw Aboagye, Prof. Mark R. Baker, Dr. Silvia Del Din

Scheduled presenter: Mr Nana Yaw Aboagye · **Organisation:** Newcastle University · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 148

DESCRIPTION OF PROPOSED TALK

Background

Persistent post-COVID fatigue is a major long-term health challenge with limited scalable management solutions [1]. Symptoms fluctuate dynamically, while conventional clinic-based assessments provide limited continuous monitoring or personalized intervention [2]. To address this gap, we developed FatigueSense, a co-designed wearable-integrated mobile health platform that combines continuous physiological monitoring, patient-reported outcomes, and artificial intelligence-driven personalization to support real-time fatigue self-management [3]. The project brought together expertise in digital health, biomedical engineering, behavioural science, and patient and public involvement to develop a clinically informed and user-centred system.

Methods

FatigueSense was co-designed with individuals living with post-COVID fatigue and evaluated in a 12-week pilot study involving 15 participants, with 14 completing follow-up. Patient contributors informed interface usability, symptom tracking workflows, fatigue visualization, and preferred recommendation strategies, including next-day fatigue forecasting and activity pacing support. The platform integrated multimodal wearable data from Fitbit Inspire 3 devices, including heart rate variability, sleep, and physical activity metrics, alongside longitudinal symptom journaling [4]. A hybrid artificial intelligence framework combined rule-based clinical safety logic, time-series fatigue prediction modelling, and behavioural clustering analytics to generate individualized recommendations for pacing, recovery, sleep optimization, and symptom prevention. Secure cloud infrastructure and controlled-access data governance procedures were implemented to support privacy, scalability, and future translational deployment.

Results

The platform processed more than 1.2 million physiological data points across the study period, achieving 99.2% synchronization reliability, a mean API response time of 420 ms, and 99.7% system uptime. User engagement and acceptability were high, with 93.3% of participants reporting that the platform was helpful for fatigue management, 78.6% finding pacing recommendations useful, 87.0% reporting improved awareness of fatigue patterns, and 73.0% reporting improved activity planning and self-management confidence. Preliminary findings demonstrate the feasibility of combining consumer wearable sensing, AI-enabled fatigue forecasting, and behavioural analytics within a scalable mobile health ecosystem for post-viral fatigue management.

Conclusion

These late-breaking findings demonstrate the potential of integrating wearable-derived digital biomarkers, artificial intelligence, and co-designed behavioural support within a personalized mobile health platform for post-COVID fatigue management. The work advances emerging approaches in digital fatigue phenotyping and adaptive self-management, while highlighting a potential pathway toward scalable remote care and future clinical translation. Larger controlled studies are now warranted to evaluate predictive performance, long-term engagement, and clinical effectiveness across broader fatigue-related conditions.

006**AI in Bioengineering I: imaging, sensing and predictive analytics****Thursday 3 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk**Detecting Activities of Daily Living Using Wearable Sensors to Support Medication State Monitoring in Parkinson's Disease**

Miss Sophia Otálora González, Dr Syed Ahmar Shah, Prof Jaap H. van Dieën, Dr Marcus Dunn, Dr Encarna Micó Amigo

Scheduled presenter: Miss Sophia Otálora González · **Organisation:** Heriot-watt University · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 162**DESCRIPTION OF PROPOSED TALK**

Parkinson's disease (PD) is a neurodegenerative disorder in which anti-Parkinsonian medication leads to fluctuations between "ON" states, when medication is effective and motor function is improved; and "OFF" states, when medication wears off and motor symptoms re-appear [1, 2]. Current clinical assessment relies on tools such as the MDS-UPDRS and patient-reported questionnaires, including the PD Questionnaire (PDQ-39) [3]. Although useful, these methods are limited by recall bias, subjectivity, and lack ecological validity, as they do not capture motor function continuously in daily life [4].

Wearable Inertial Measurement Units (IMUs) enable continuous and objective monitoring of motor function in daily life over extended periods [5]. While gait analysis has shown strong potential for distinguishing medication states in PD, gait represents only a small proportion of daily behaviour, as people with Parkinson's spend much of their time performing Activities of Daily Living (ADLs). Therefore, there is a need to identify and assess ADL performance in real-world settings, where motor fluctuations may affect independence, functional ability, and quality of life beyond walking alone.

The selected activities were informed by the PDQ-39, since it reflects aspects of daily life relevant to patients with PD [3]. The protocol was co-designed by a Patient and Public Involvement (PPI) consultation with 12 stakeholders, including six people with Parkinson's, three clinicians, and three carers. Thematic analysis identified five key themes: the clinical value of objective monitoring, usability constraints, psychological barriers, data interpretation needs, and practical feasibility. These findings informed ADL prioritisation, sensor selection, monitoring duration, and output design.

Twenty healthy participants performed 10 ADLs, including writing, washing dishes, drinking tea, and putting on a jacket, while wearing six wearable sensors. A Random Forest classifier with Leave-One-Subject-Out validation achieved 84% accuracy and an F1-score of 0.81. Writing was classified most accurately, with an F1-score of 0.93, followed by washing dishes with 0.90 and lying down with 0.89. Fine-motor tasks, such as drinking tea, were more challenging, with an F1-score of 0.68. The best sensor configuration included the right wrist, lower back, and left thigh. This setup balanced classification performance with the wearability needs identified through PPIE.

These findings show that wearable sensors and machine learning can reliably detect patient-relevant ADLs. This provides a baseline for real-world medication state monitoring in PD. Future work will validate ADL detection in people with Parkinson's and assess medication states during daily life. In the long term, this approach could support personalised and data-driven treatment adjustment.

006**AI in Bioengineering I: imaging, sensing and predictive analytics****Thursday 3 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk**FMReg: Unsupervised Deformable Image Registration with Flow Matching**

Miss Ruojun Zhang

Scheduled presenter: Miss Ruojun Zhang · **Organisation:** University of Liverpool · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 188**DESCRIPTION OF PROPOSED TALK**

Unsupervised deformable image registration remains a fundamental and challenging task in medical imaging. It seeks to establish a dense spatial correspondence between a pair of fixed and moving images by estimating a nonlinear geometric transformation. Accurate deformable registration underpins numerous clinical workflows, including population atlas construction, longitudinal treatment response evaluation, and disease progression monitoring.

Classical registration methods based on iterative optimization, such as LDDMM and SyN, often struggle with nonconvex optimization and costly computation, limiting their scalability. Deep learning-based methods have become dominant due to their high accuracy and computational efficiency during inference. Current learning-based registration networks primarily include U-Net, Transformers, Neural ODEs, and diffusion models. While promising, diffusion-based registration methods often suffer from multi-step inference and the need for Exponential Moving Average (EMA) to stabilize training.

Recently, flow-based models have emerged as a strong alternative to diffusion-based approaches in generative modeling. Compared with diffusion models, flow-based methods offer more stable training dynamics and one-step sampling during inference. Leveraging these advantages, we propose FMReg, the first framework to adapt flow matching—a generative paradigm featuring simpler objectives and straighter transport paths—to image registration. FMReg bridges the conceptual gap between pixel-space generative modeling and coordinate-space registration by predicting a stationary velocity field (SVF) while deriving a novel velocity loss from the flow matching objective. This design stabilizes training without EMA, thereby enhancing memory efficiency and enabling faster convergence perception. We design a hybrid SwinDiT-Unet backbone that integrates the Diffusion Swin-Transformer with a U-Net architecture to capture both global anatomical context and fine-grained local deformations.

Experiments on 2D cardiac (ACDC) and 3D brain (IXI, OASIS) datasets demonstrate that FMReg achieves competitive or superior registration accuracy. Furthermore, FMReg produces near-diffeomorphic deformation fields with topology-folding rates two orders of magnitude lower than existing learning-based baselines, showcasing its exceptional robustness and stability.

006

AI in Bioengineering I: imaging, sensing and predictive analytics

Thursday 3 September 2026 · 13:00-14:00 · Space One and Two

Chairs: Professor Yalin Zheng · Dr Cameron Kirk

Sensing the Mind: A Multi-Task Multimodal AI Integrating Retinal Angiography, Auditory Phenotyping, Chemosensory Testing and Plasma Alzheimer Biomarkers for Early Detection of Mild Cognitive Impairment.

Ms Feliciano Catino, Dr Angela Maria Ruffo, Dr Fabio Stefano Castellana, Dr Luisa Lampignano, Ms Viviana Giannoccaro, Dr Roberta Zupo, Dr Giovanni Boero, Dr Giuseppe Addabbo, Dr Francesco Pignatelli, Dr Alfredo Niro, Dr Nicola Quaranta, Prof Donato Impedovo, Dr Masoud Isaneshad, Dr Carlo Santoro, Prof Yalin Zheng, Prof Rodolfo Sardone

Scheduled presenter: Ms Feliciano Catino · **Organisation:** University of Bari · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 204

DESCRIPTION OF PROPOSED TALK

Background

. Early identification of mild cognitive impairment (MCI) before overt clinical conversion remains a translational bottleneck in dementia prevention. Converging evidence supports a multi-sensory frailty hypothesis whereby retinal microvascular, central-auditory and chemosensory deficits co-occur with mesial-temporal atrophy and emerging Alzheimer pathology years before measurable decline on the Montreal Cognitive Assessment (MoCA). No validated multimodal artificial intelligence model has yet integrated these heterogeneous signals into a single, interpretable, dual-task pipeline calibrated for both categorical (MCI vs control) and continuous (MoCA) inference under TRIPOD-AI standards.

Methods

. Data were drawn from an ongoing prospective observational study (ethics committee approval obtained). A balanced cohort of 100 older adults (50 controls, 50 MCI defined by normative MoCA<26; age 65-89) underwent multimodal phenotyping: OCT-angiography (superficial/deep vessel density, RNFL, GCC, FAZ), 3-T MRI volumetrics (hippocampus, amygdala, lobar and precuneal volumes), pure-tone audiometry, Synthetic Sentence Identification with ipsilateral competition, Sniff Magnitude Test, Taste Strip score, and plasma Alzheimer biomarkers (Aβ42/40, p-Tau181/217, NfL, GFAP, ApoE4 fraction). A Feature-Tokeniser Transformer with modality-specific embeddings and six cross-modal attention layers was trained jointly on two heads (BCE for MCI classification, MSE for MoCA regression) balanced via homoscedastic uncertainty weighting; SCARF contrastive pre-training preceded fine-tuning. Performance was estimated by nested 10×5 cross-validation with 1000 bootstrap resamples and benchmarked against TabPFN v2, XGBoost, and a demographics-plus-education logistic regression. SHapley Additive exPlanations provided cross-modal interpretability; TRIPOD-AI reporting standards were applied.

Results

. The multi-task FT-Transformer achieved AUROC = 0.91 (95% CI, 0.84-0.96), AUPRC = 0.93, accuracy = 0.85, sensitivity = 0.87, specificity = 0.80, Brier score = 0.13, and calibration slope = 0.94 for MCI classification. MoCA regression yielded root-mean-square error = 2.4 (95% CI, 1.9-3.0) and R² = 0.62. The multimodal architecture significantly outperformed TabPFN v2 (AUROC = 0.88), XGBoost (0.84) and the demographics-only logistic baseline (0.71; DeLong p < 0.01). SHAP cohort-level attribution identified Sniff Magnitude score, OCT-A deep vessel density, plasma p-Tau217, hippocampal volume, and pure-tone audiometric average as the five strongest contributors, supporting a convergent neurobiological signature spanning retinal microvasculature, olfactory bulb pathology, central auditory processing and medial-temporal degeneration.

Conclusions

. Multi-task multimodal deep learning integrating non-invasive sensory phenotyping with plasma Alzheimer biomarkers identifies MCI with high discrimination and yields calibrated MoCA estimates. The interpretable cross-modal signature converges with the sensory-frailty paradigm and supports translational deployment as a community-level cognitive triage tool. External validation in independent multi-centre cohorts is ongoing.

Keywords. mild cognitive impairment; multimodal artificial intelligence; OCT-angiography; plasma p-Tau217; multi-task learning; FT-Transformer; sensory frailty; TRIPOD-AI.

006

AI in Bioengineering I: imaging, sensing and predictive analytics

Thursday 3 September 2026 · 13:00-14:00 · Space One and Two

Chairs: Professor Yalin Zheng · Dr Cameron Kirk

Temporal Dominance in EEG-Based Alzheimer's Disease Classification: A Regional Analysis of Spectral and Complexity Features

Mr Kerimay Sari, Dr Daniel Abasolo, Dr Samaneh Kouchaki

Scheduled presenter: Mr Kerimay Sari · **Organisation:** University of Surrey · **Programme slot:** 13:50-14:00 · **Order:** 6 · **Paper:** 94

DESCRIPTION OF PROPOSED TALK

Alzheimer's disease (AD) is characterised by early neurodegenerative and functional alterations in the medial temporal lobe, particularly within the hippocampal formation. Consequently, electroencephalogram (EEG) features from temporal electrodes may offer superior discriminative power for AD diagnosis compared to other regions. This study examined the regional contributions of spectral and complexity-based EEG features to AD classification using support vector machine (SVM).

Eyes-closed resting-state EEG recordings sampled at 200 Hz were sourced from the publicly available CAUEEG dataset, which included 82 AD patients (68.68 ± 7.06 years) and 82 age-matched healthy controls (67.17 ± 6.79 years). Following the international 10-20 system, nineteen EEG electrodes were placed and organised into six cortical regions: frontal (Fp1, Fp2, F3, F4, Fz), central (C3, C4, Cz), left temporal (T3, T5, F7), right temporal (T4, T6, F8), occipital (O1, O2), and parietal (P3, Pz, P4). Frequency-domain features (median frequency, relative band power, and power ratios) and complexity features (auto mutual information, detrended fluctuation analysis, dispersion entropy, fuzzy entropy, Hjorth complexity, Hjorth mobility, Lempel-Ziv complexity, and sample entropy) were extracted from twenty 5-s EEG epochs per participant. Classification performance was evaluated with 5-fold nested cross-validation. The inner loop optimized SVM hyperparameters, and the outer loop estimated classification accuracy.

The temporal regions demonstrated the highest classification accuracy for both feature types. For complexity features, the left temporal region showed the highest accuracy (69.32%), followed by the right temporal region (65.92%); other regions ranged from 58.99% to 64.02%. Frequency features showed a similar pattern; left and right temporal regions reached the highest accuracies of 72.68% and 70.64%, respectively. Statistical analysis confirmed significant regional differences in classification performance, as indicated by the Friedman test ($\chi^2 = 53.44$, $p < 0.001$; Kendall's $W = 0.668$). Bonferroni-corrected Wilcoxon signed-rank tests showed that the left temporal region significantly outperformed all other regions, whereas the right temporal region outperformed all non-temporal regions.

The feature-wise descriptive analysis showed that the temporal regions achieved the highest accuracy across all 16 features. The left temporal region performed best for 13 features, whereas the right temporal region performed best for 3 features. These results support the idea that temporal EEG features, particularly those from the left temporal region, are the most informative regional markers for classifying AD.

007**Computational Modelling I: multiscale physiology and transport****Thursday 3 September 2026** · 13:00-13:50 · Space Four**Chairs:** Dr Ahmed Abass · Professor Blanca Rodriguez

Assessing the impact of interference and crosstalk in bioelectrical EMG signals between muscles with the Finite Element Method.

Mr Nikolaos Bardas, Professor Edward Chadwick

Scheduled presenter: Mr Nikolaos Bardas · **Organisation:** University of Aberdeen · **Programme slot:** 13:00-13:10 · **Order:** 1 · **Paper:** 13

DESCRIPTION OF PROPOSED TALK

Electromyography (EMG) quantifies the electrical activity produced by muscles in response to neural signals from the brain. These myoelectric signals result from changes in muscle cell membrane potential. EMG enables the assessment of signal transmission and reception, thereby supporting the diagnosis of neuromuscular disorders. A primary challenge in EMG is crosstalk, which arises when signals from adjacent muscles interfere due to the propagation of electrical activity through body tissues. In electronics, crosstalk refers to the influence of one signal on another in neighbouring circuits or channels. All electrical signals generate surrounding fields, and the overlap of these fields can cause interference, resulting in crosstalk and the unintended mixing of information. For reliable human-machine interfaces or accurate clinical diagnoses, it is crucial to record clean, specific signals that faithfully represent the intended neural information. The target signal must remain free from contamination by signals from adjacent tissues to ensure reliable results.

The objective of this research is to assess EMG signal recordings and determine the optimal electrode locations on the skin. Finite Element Analysis (FEA) will be employed to simulate the behaviour of electric fields in three-dimensional models generated using COMSOL Multiphysics. This methodology enables visualisation of the distribution of EMG-generated electric fields within body tissues and exploration of their interaction.

Finite Element Analysis was utilized to create a three-dimensional model of a healthy individual's lower leg, with anatomical accuracy ensured through the use of MRI data. Specialised software was subsequently applied to analyse raw data collected by EMG sensors, which measured muscle activity both intramuscularly and on the skin surface during experiments conducted on a single volunteer.

To assess the model's accuracy, a twitch input was delivered via an intramuscular electrode and measured with surface EMG. The Single-Input Single-Output (SISO) approach examines one input and one output at a time for model validation.

The positions of the surface EMG electrodes on the participant's lower leg were replicated in the three-dimensional simulation model. These positions were measured during the experiment and designated as specific points in the model to enable precise comparison.

For the analysis of results, a Multi-Input Multi-Output (MIMO) approach was used to optimise the model's multiple electrode configurations. This guides precise electrode placement and improves signal specificity. The constrained minimisation function/routine is used to estimate the contribution of the input signals to the output measured signals by comparing modelled domain probes with the participant's measured electromyography (EMG) data.

007**Computational Modelling I: multiscale physiology and transport****Thursday 3 September 2026** · 13:00-13:50 · Space Four**Chairs:** Dr Ahmed Abass · Professor Blanca Rodriguez**Decoding the Multiscale and Physicochemical Processes in Brain Tumours**

Dr Yi Yang, Dr Tian Yuan, Dr Yingfang Zhou, Prof. Dubravka Pokrajac, Dr Wenbo Zhan, Prof. Daniele Dini

Scheduled presenter: Dr Yi Yang · **Organisation:** Imperial College London · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 58**DESCRIPTION OF PROPOSED TALK**

Brain tumours, particularly gliomas, remain among the most lethal malignancies worldwide, with therapeutic outcomes limited by multiple factors, such as abnormal vasculature, elevated interstitial fluid pressure and highly dense extracellular matrix. Despite advances such as convection-enhanced delivery designed to bypass the blood-brain barrier, clinical translation has yielded limited success. This can be attributed to the multiple physiological and physicochemical processes that are determined by the interplays between the biological properties of the tumours and the transport properties of the drugs. To address this challenge, we have established a mathematical framework that captures the multiscale and physicochemical processes governing biofluid and drug transport in brain tumours. Within this framework, we have successfully: (i) validated the mathematical models through experiments across different scales, (ii) gained a deeper understanding of convection-enhanced nanoparticle-encapsulated chemotherapy drug delivery [1,2], via utilising a patient-specific 3D computational model with multiphysics modelling, (iii) revealed pore-scale biofluid dynamics in different World Health Organisation grades of brain tumour by incorporating the nanoscale effect introduced by the extracellular matrix [3], (iv) mathematically described and quantified the nanoparticle diffusion in the microstructures of brain tumours by employing a mechanics-based particle tracing model [4], (v) envisaged a next-generation therapeutic ecosystem for infusion-based brain drug delivery [5]. The developed computational framework enables a comprehensive understanding of multiscale and physicochemical processes in brain tumours, providing mechanistic insights into therapeutic resistance and offering predictive tools for optimising drug delivery strategies in neuro-oncology [6].

007**Computational Modelling I: multiscale physiology and transport****Thursday 3 September 2026** · 13:00-13:50 · Space Four**Chairs:** Dr Ahmed Abass · Professor Blanca Rodriguez**Validation of Sleep Assessment Algorithms Using Lower-Back-Worn Accelerometry**

Mr Mohammadreza Sedghi, Dr Silvia Del Din, Prof Alison J. Yarnall, Miss Emma Packer, Prof Lynn Rochester, Prof John-Paul Paul, Dr Lisa Alcock, Dr Rachael A. Lawson

Scheduled presenter: Mr Mohammadreza Sedghi · **Organisation:** Newcastle University · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 61**DESCRIPTION OF PROPOSED TALK**

Sleep problems affect up to 90% of people with Parkinson's disease (PD), significantly impairing daily functioning and quality of life. Accurate sleep monitoring is therefore crucial. Traditional methods such as questionnaires and sleep diaries are susceptible to recall bias, while polysomnography is resource-intensive and impractical for long-term assessment. Wearable devices offer a practical alternative and are increasingly adopted in sleep research. Most PD studies on sleep use wrist-worn devices, yet evidence from other wearable applications, including analysis of gait and posture, which are key to understanding sleep-related functional decline, suggests that lower-back placement may yield more accurate and representative results. To support holistic, real-world monitoring using a single sensor, it is essential to understand how device placement influences sleep metrics. The GGIR algorithm, an open-source R package developed for wrist-worn accelerometer data, is widely used to estimate sleep. This study evaluated GGIR's performance when applied to lower-back-worn devices.

Data were obtained from two studies (CiC-PD, $n=25$; DELIRIUM-PD, $n=16$), where participants with PD simultaneously wore Axivity-Ax6 devices on the wrist (watchstrap) and lower-back (skin-adhered). Data were processed in GGIR using 210 parameter combinations, varying angle ($A=0.5-25^\circ$) and time window ($T=1-15\text{min}$) thresholds. Sleep onset (SON), number of awakenings (NAWK), and wake after sleep onset (WASO) from the lower-back-worn device were compared with wrist-based estimates. Mean differences were assessed with within-subject ANOVA and post-hoc Tukey's tests; effect sizes were computed using Cohen's d , and agreement was evaluated via Pearson correlations and intraclass correlation coefficients (ICC).

Optimal thresholds minimising mean absolute error (MAE) were T2A0.5 for SON ($\text{MAE}=1.28\text{h}$), T10A10 for NAWK ($\text{MAE}=3.57$), and T1A5 for WASO ($\text{MAE}=2.01\text{h}$). The agreement between wrist and lower-back placements was limited. SON performed the best, with moderate agreement ($r=0.46, \text{ICC}=0.44$) and small bias ($d=0.13$); consistent with this, there was no statistically significant difference between wrist and lower-back devices ($p=0.19$).

NAWK showed weaker agreement ($r=0.38, \text{ICC}=0.38; d=0.18$), with no significant device placement effect ($p=0.16$). WASO performed poorly ($r=0.13, \text{ICC}=0.12; d=-0.17$), similarly showing no significant difference in sensor placement ($p=0.25$).

These results indicate that device placement has a limited effect on mean sleep estimates derived from GGIR, but agreement between device placement varies significantly by sleep outcome. SON offers modest comparability, NAWK had weaker consistency, and WASO showed low reliability. Although mean estimates were similar across device placements, they may obscure individual variability. Future work should validate these findings in larger samples against polysomnography to enhance device-placement comparability and support robust, single-sensor monitoring in PD.

007**Computational Modelling I: multiscale physiology and transport****Thursday 3 September 2026** · 13:00-13:50 · Space Four**Chairs:** Dr Ahmed Abass · Professor Blanca Rodriguez

Fluid-mechanical mechanisms governing localised drug injection into soft tissues

Dr Tian Yuan, Dr Michela Esposito, Miss Saki Okada, Mr Stefan Antonowicz, Dr Yi Yang, Dr Wenbo Zhan, Professor Michael Chen, Dr Sara Valpione, Professor Ferdinando Rodriguez y Baena, Professor Daniele Dini

Scheduled presenter: Dr Tian Yuan · **Organisation:** Imperial College London · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 63

DESCRIPTION OF PROPOSED TALK

Fluid injection into soft biological tissue is widely used for localised drug delivery. However, drug distribution after injection is often difficult to predict. Under the same injection conditions, drugs may remain localised near the needle, spread through the extracellular space (ECS), or undergo backflow, where injected drugs escape backwards along the needle-tissue interface rather than penetrating the target tissue. Recent modelling and experimental studies have shown that tissue deformation, hydraulic permeability, interstitial pressure, injection flow rate, device geometry and backflow can all strongly influence local delivery outcomes [1-5].

Here, we examine whether tissue permeability can determine transitions between injection regimes. Fresh soft tissue samples were injected under controlled flow conditions while pressure and flow rate were recorded. Apparent permeability was first estimated from the pressure-flow rate response under a low injection rate, where injected fluid was expected to move primarily through the native ECS without substantial tissue disruption or needle-track backflow. Higher flow injections were then performed to identify transitions from ECS-limited spreading to pressure-induced internal pathway formation and, at higher flow rates, needle-track backflow.

Three regimes were identified. At low flow rates, transport was ECS-limited. At intermediate flow rates, pressure accumulated before a sudden release, consistent with internal pathway opening and enhanced convective spreading. At high flow rates, fluid preferentially escaped backwards along the needle track, producing backflow and limiting effective tissue penetration.

A biomechanical computational model was subsequently developed to link tissue transport properties with the observed regime transitions. The model successfully captured the observed regime transitions and provided a mechanistic framework for predicting injection outcomes. Overall, this work identifies key fluid-mechanical mechanisms governing localised injection into soft tissues and provides a quantitative tool for optimising local drug delivery efficiency.

007**Computational Modelling I: multiscale physiology and transport****Thursday 3 September 2026** · 13:00-13:50 · Space Four**Chairs:** Dr Ahmed Abass · Professor Blanca Rodriguez

A Mathematical Model for Serotonin Dynamics from Human Derived Serotonergic Spheroids

Ms Joanna Mialkowska, Pablo Prieto, Joel Greenfield, Bettina Bohl, Michael Reed, Parastoo Hashemi

Scheduled presenter: Ms Joanna Mialkowska · **Organisation:** Imperial College London · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 110

DESCRIPTION OF PROPOSED TALK

Despite being the most common mental disorder affecting over 300 million people worldwide, the neurobiological mechanisms underlying depression are not well understood. Clinical data additionally reveals that there is significant variability in treatment efficacy between individuals and across antidepressants, the most common being selective serotonin reuptake inhibitors (SSRIs). The reasons behind this remain unresolved, partly due to the technical challenge of measuring human brain chemistry in vivo. The use of human induced pluripotent stem cells (hiPSCs) offers a novel platform to extend beyond animal models and study human neuromodulatory dynamics of serotonin ex vivo. We utilize fast scan cyclic voltammetry (FSCV) for real-time measurement of serotonin release and reuptake from hiPSC spheroids composed of serotonergic neurons. FSCV relies on applying a specialized triangular voltage sweep across a carbon fibre microelectrode placed inside neuronal tissue. In turn, an electron exchange between the target species, serotonin in this case, and the electrode surface is induced and produces current proportional to the species concentration. Using this model, we electrically stimulate the spheroids over two-hour periods and measure their serotonin dynamics with or without pharmacological treatments such as SSRIs. We then develop a deterministic mathematical model utilizing Michaelis-Menten kinetics combined with several novel terms for autoinhibitory feedback and diffusion. This differential equation approach successfully replicates serotonergic spheroid dynamics in silico, allowing for neuropharmacological hypothesis generation and validation. Our findings establish hiPSC serotonergic spheroids combined with FSCV as a promising ex vivo platform for studying serotonin dynamics, with implications for translational models of antidepressant efficacy.

008**Biomaterials I: therapeutic materials and drug delivery****Thursday 3 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Perivascular biodegradable mesh for the delivery of dexamethasone to extend vein graft patency in coronary artery bypass graft

Ms Swarnapriya Kasi, Dr Mustafa Zakkar, Dr Jennifer Shepherd

Scheduled presenter: Ms Swarnapriya Kasi/ Dr Jenny Shepherd · **Organisation:** University of Leicester · **Programme slot:** 13:00-13:10 · **Order:** 1 · **Paper:** 26

DESCRIPTION OF PROPOSED TALK

Introduction

The Long saphenous vein is the most used conduit to achieve revascularisation in ischemic heart disease. However arterial hemodynamics in the vein triggers a proinflammatory state which ultimately leads to a chain of events that contribute to vein graft failure. With failure of the vein graft revision surgery is required. Patency of vein grafts can be extended by a range of means including pharmacological treatment of several precursor conditions of VGF. Zakkar et al found that the venous endothelial cells arterialised in vein grafts when pretreated with dexamethasone which could improve graft patency.

Aim

. To fabricate a biodegradable unidirectional drug releasing perivascular conduit to target early inflammation and thereby improve patency rates in vein grafts.

Materials and Methods

Insoluble type 1 collagen isolated from bovine achilles tendon was swollen in acetic acid for 48 hours and homogenised to prepare collagen slurry. 1 wt% collagen was frozen for 1 hour (-20°C) and then dexamethasone containing collagen slurry poured on top prior to lyophilisation (VirTis AdVantage Freezedryer). Optimisation of drug release was considered by loading various drug doses in various densities of collagen (0.5 wt%, 1wt% and 2wt%) to help understand drug release kinetics. In vitro degradation test and UV visible spectrophotometry were used to quantify drug release. Sterilisation was carried out using UV B of wavelength 302nm. Non porous collagen was fabricated by air drying 1wt% collagen. Fabrication of tubular perivascular conduits was a multi step process involving lyophilisation. Fourier transformation infrared spectroscopy and scanning electron microscopy were used for physiochemical analysis. Drug uptake by vein segments from the collagen constructs was also investigated in in culture models.

Results

Dual layer collagen constructs achieved desired drug release profile to tackle early inflammation. The volume of collagen construct was further reduced to achieve neutral pH conditions and cater to fabrication for all types of grafts. UV sterilisation of collagen constructs was successful and did not alter drug release profile. Moreover, unidirectional drug release was clearly observed. Fabrication of perivascular conduits were also successful exhibiting good integration with barrier film for up to 28 days. Final quantification of dexamethasone uptake in vein explants in in vitro culture models showed steady drug uptake between day 1 and 7.

Conclusion

Tubular perivascular, drug-loaded collagen-based conduits were successfully produced. Drug release was shown to be both unidirectional and at a rate hypothesised to be optimal for treatment of early inflammation, with uptake measured in vein segments.

008**Biomaterials I: therapeutic materials and drug delivery****Thursday 3 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Diffusion-Controlled Fibrin Gelation via In Situ Thrombin Delivery

Ms Qandeel Saleem, Dr. Natasha Shirshova, Dr. Timea Feller, Dr. Anders Aufderhorst-Roberts

Scheduled presenter: Ms Qandeel Saleem · **Organisation:** Durham University · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 156

DESCRIPTION OF PROPOSED TALK

Fibrin is the primary structural component of blood clots and plays a central role in haemostasis, wound healing, and tissue regeneration. The structure and mechanical properties of fibrin networks are governed by thrombin-mediated polymerisation, making controlled fibrin gelation highly relevant to applications including tissue engineering, injectable biomaterials, bioprinting, and in vitro thrombosis models.

Here, we present a custom-designed rheodialysis platform for studying fibrin gelation under controlled in situ thrombin delivery. A bespoke flow cell integrated into the rheometer base plate enables thrombin to diffuse through a semi-permeable membrane directly into the sample during rheological measurements. Unlike conventional premixing approaches, this method initiates gelation gradually, enabling continuous monitoring of fibrin network formation under diffusion-controlled conditions.

Using this platform, we demonstrate reproducible in-situ fibrin gelation and resolve the evolving viscoelastic response throughout clot development under ramped thrombin delivery. These measurements provide insight into how controlled biochemical transport influences fibrin network formation and mechanical evolution. This work establishes rheodialysis as a versatile tool for studying dynamic hydrogel assembly and provides an experimental framework for designing fibrin-based biomaterials with tunable structural and mechanical properties for biomedical applications.

008**Biomaterials I: therapeutic materials and drug delivery****Thursday 3 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

In vitro vitreous-cell model for pharmacokinetic analysis

Miss Moira Lorenzo Lopez, Dr Victoria Kearns, Professor Eann Patterson, Professor Jude Curran

Scheduled presenter: Miss Moira Lorenzo Lopez · **Organisation:** University of Liverpool · **Programme slot:** 13:20-13:30 ·**Order:** 3 · **Paper:** 33

DESCRIPTION OF PROPOSED TALK

Effective retinal drug delivery via the vitreous humour requires the therapeutic agent to first cross the vitreous/gel-like matrix to reach the target tissue. Therefore, it is essential to include the vitreous humour, or mimics of it, in the development of in vitro models used as preclinical screening tools for the design of nanoparticle-based drug delivery systems [1]. These models must support the assessment of nanoparticle transport and interactions within the complex vitreous matrix, which can substantially influence the effective concentration of therapeutics reaching the retina.

This study presents the development of a multicomponent in vitro model that combines an optimised synthetic vitreous humour analogue, based on an agar and hyaluronic acid hydrogel [2], and an adherent retinal cell layer to study the transport and distribution of gold nanoparticles across the vitreous towards the retinal cell layer. This is achieved by exploiting the capabilities of an emerging label-free nanoparticle tracking platform, which can characterise the movement of nanoentities in complex biological environments [3]. The platform also generates data that provides insight into the effects of mechanical, physical, and biological factors on nanocarrier movement.

The model effectively characterised how increasing system complexity influenced nanoparticle diffusion. In serum-rich media, nanoparticles incubated for 24h showed significantly higher diffusion rates when compared to serum-free media, suggesting the presence of nanoparticle-protein interactions that prevented particle-particle aggregation. The introduction of an ARPE-19 cell layer further increased biological complexity reflected by greater variability in nanoparticle diffusion. Finally, the addition of a vitreous analogue layer resulted in a bimodal diffusion distribution, successfully replicating the distinct aqueous and gel phases characteristic of the vitreous humour.

This experimental model provides a mechanism to design and test nanoentity properties and understand how these properties can be used to control carrier-protein interactions, movement and delivery to a cell layer through complex environments.

008**Biomaterials I: therapeutic materials and drug delivery****Thursday 3 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

In-Situ Alloying via Laser Powder-Bed Fusion to Explore Minor Element Addition for Biological Functionality

Dr Luke Carter, Dr Victor Villapún, Dr Daisy Rabbitt, Mr Oliver Page, Miss Amy Herman, Dr Sophie Cox

Scheduled presenter: Dr Luke Carter · **Organisation:** University of Birmingham · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 42

DESCRIPTION OF PROPOSED TALK

Alloy selection and development for bone replacing implants tends to focus on materials able to deliver suitable mechanical properties for the application whilst displaying low-cytotoxicity. This is no more apparent than in the surge of β -titanium development to minimise the elastic modulus and reduce stress-shielding failure. There is however a wealth of data showing that specific elements may provide additional biological benefits that would address the broader needs of the recovering patient elevating the implant material above simply providing mechanical support [1]. Minor element addition to fine tune targeted aspects of alloy performance has long been using in the aerospace industry for materials operating in extreme environments with some nickel superalloys containing up to 10 different elements to meet tailor their properties.

Critical to realising this benefit is the discovery phase whereby the compositional and microstructural thresholds of target behaviours can be established before being integrated into suitable alloy systems. Traditional arc melting methods tend to be slow, often requiring several melts to ensure homogeneity, limited in terms of final geometry, and with the potential for crucible interactions and contamination. Laser Powder-Bed Fusion (PBF-LB) offers an accelerated route whereby simple powder blends are alloyed in-situ during the laser melting process with composition easily varied by adjusting the feedstock ratio.

In this research, we explore the use of this method to accelerate discovery of behavioural thresholds with both Cu and Sn additions. In the former, novel processing techniques have been employed to generate compositionally graded specimens that dramatically reduce the burden of biological testing allowing for antimicrobial breakpoints to be easily established using a single specimen. This has then been integrated into an existing alloy to demonstrate antimicrobial efficacy of Ti64+6%Cu.

Ti-xSn alloys have also been systematically explored, characterising their cytotoxicity, osteogenic, angiogenic, immune, and antimicrobial response. Sn additions up to 4.4% demonstrate potentially improved bone formation through MC3TC gene expression and mineralisation assays. These suggest potential benefits for osteointegration in bone replacing implants.

For both, the material microstructure has been characterised alongside the biological performance, taking a critical view of both the strengths and challenges of using in-situ PBF-LB alloying as a discovery method.

008**Biomaterials I: therapeutic materials and drug delivery****Thursday 3 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Sandwich-Structured Electrospun PLGA/PVA Membranes for Sustained Release of Quaternary Ammonium Compounds in Periodontal Therapy

Dr Ting Chen, Dr Jenny Averyard, Prof Raechelle D'Sa

Scheduled presenter: Dr Ting Chen (Ziyue Su) · **Organisation:** University of Liverpool · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 53

DESCRIPTION OF PROPOSED TALK

Periodontal infections require local antimicrobial systems capable of maintaining therapeutic activity within the gingival pocket, where pathogenic biofilms are difficult to eradicate and antimicrobial agents may be rapidly diluted or cleared.[1] Although electrospun quaternary ammonium compound (QAC)-loaded polyvinyl alcohol (PVA) nanofibers provide strong antimicrobial activity, their hydrophilic structure promotes rapid burst release, limiting the duration of biofilm exposure. To address this limitation, sandwich-structured membranes comprising poly(lactic-co-glycolic acid) (PLGA) outer layers and a QAC-loaded PVA intermediate layer were fabricated by sequential electrospinning. Two QACs, benzyltriethylammonium chloride (BTEAC) and benzyldimethyldodecylammonium chloride (BDMDAC), were incorporated, and PLGA spinning duration was varied from 0.5 to 2 h to modulate barrier thickness and release behaviour.

Physicochemical characterisation confirmed the formation of well-defined trilayer membranes with preserved chemical integrity and no evidence of inter-layer chemical interactions. Increasing PLGA spinning duration altered membrane porosity, increased surface hydrophobicity, and shifted the mechanical response from brittle to ductile, with failure strains exceeding 200%. Release studies showed that the PLGA/PVA-QAC/PLGA architecture extended QAC release to over 4 h, delaying the burst release observed from monolayer PVA fibres. Peppas-Sahlin modelling further demonstrated a transition from swelling-dominated release to more diffusion-controlled release as PLGA barrier thickness increased, indicating that release mechanism could be tuned through membrane design.

Antimicrobial testing against five oral microorganisms, including *Streptococcus mutans*, *Porphyromonas gingivalis*, and *Candida albicans*, showed that BDMDAC-loaded membranes reduced planktonic *S. mutans* and *P. gingivalis* to below detectable levels and provided substantial antifungal activity, whereas BTEAC-loaded membranes were particularly effective against Gram-negative bacteria. Biofilm inhibition assays supported these findings, indicating that delayed release was more beneficial for biofilm control than rapid initial delivery. Cytocompatibility assessment using L929 fibroblasts and human dental pulp stem cells identified the BDMDAC-loaded 1 h PLGA formulation as non-cytotoxic in both cell models while maintaining broad-spectrum antimicrobial efficacy.

These findings demonstrate that PLGA/PVA-QAC/PLGA sandwich membranes provide a tuneable platform for controlling antimicrobial release, enhancing oral biofilm inhibition, and maintaining cytocompatibility, supporting their potential use as local antimicrobial membranes for periodontal therapy.

009**TADCT Sponsored Session: Aortic Haemodynamics and Mechanics****Thursday 3 September 2026** · 13:00-14:00 · Space Six
Chairs: Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Subject Specific Computational Haemodynamic Analysis of Pressure Transmission during Partial Arterial Opening in Cuff Oscillometric Measurement

Mr Talha Akhtar, Dr Philip Lewis, Dr Ajay Harish, Dr Parthasarathi Mandal

Scheduled presenter: Mr Talha Akhtar · **Organisation:** University of Manchester · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 113

DESCRIPTION OF PROPOSED TALK

Blood pressure (BP) is a key indicator of cardiovascular health, and sustained hypertension can lead to disability, cardiovascular complications and premature death. The 2025 WHO global report on hypertension states that 1.4 billion adults aged 30-79 years were affected worldwide in 2024 [1]. Unfortunately, hypertension has no noticeable symptoms, its diagnosis and management depend strongly on accurate BP measurement. Automated oscillometric monitors are widely used in clinical practice because they are non-invasive and easy to operate. These devices estimate BP during cuff deflation in three stages: complete brachial artery occlusion above systolic BP, partial arterial opening between systolic and diastolic BP, and full flow restoration below diastolic BP. During partial opening, altered blood-flow dynamics within the compressed brachial artery can change the amplitude, timing and shape of the transmitted pressure waveform, potentially affecting the oscillometric signal used for BP estimation [2].

This study uses computational fluid dynamics to examine pressure waveform transmission through a cuff-compressed, partially open brachial artery. An idealised artery with localised cuff-induced compression was modelled in ANSYS Fluent, with blood treated as a non-Newtonian laminar fluid using the Carreau viscosity model. Six haemodynamic cases were analysed, with two cases representing each BP category: normal BP (Case 1,2: 119/69, 115/68), elevated BP (Case 3,4: 123/84, 136/84) and hypertension (Case 5,6: 144/94, 151/90), classified according to European BP guidelines. Physiological pulsatile inlet velocity and pressure-based outlet conditions were applied, and transient pressure waveforms were extracted over one complete cardiac cycle at locations proximal and distal to the compressed segment. The proximal signal was used as the reference before waveform passage through the compressed region, while the distal signal represented the post-compression response. The pressure signals were analysed using the discrete Fast Fourier Transform-based harmonic transfer function method to quantify harmonic transmission, attenuation, and equivalent delay of pressure waveform across the partial open segment.

Across the six cases, peak-to-peak and fundamental harmonic transmission were preserved, indicating minimal change in overall pulse magnitude. However, higher-harmonic transmission decreased to 77.54-92.01%, producing 11-24% waveform shape loss and 14-19 ms delay. Harmonic reconstruction showed that partial opening state mainly altered the sharp systolic rise and smaller waveform features rather than simply reducing overall pressure amplitude. These findings show that unchanged pulse amplitude can conceal systolic waveform distortion during partial arterial opening. Fourier Transform-based analysis captured these hidden changes, providing device-relevant metrics to support improved validation and correction of oscillometric measurement bias.

009

TADCT Sponsored Session: Aortic Haemodynamics and Mechanics**Thursday 3 September 2026** · 13:00-14:00 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Experimental Investigation of Pulsatile Flow in Graft-Treated Aortic Models

Miss Eleanor Barton, Miss Rebecca Lewis, Dr Joshua Lowe, Professor Jean-Baptiste Souppiez, Dr Craig Maclean, Dr Laura Leslie, Dr Alexander Zhiaglov, Dr John Simms, Dr Patrick Geoghegan

Scheduled presenter: Miss Eleanor Barton · **Organisation:** Aston University · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 102

DESCRIPTION OF PROPOSED TALK

Cardiovascular disease affecting the aorta usually presents as aneurysms or dissections and is often treated by surgical replacement of diseased sections with vascular grafts. Although these grafts restore vessel integrity, their geometry and rigidity can alter local haemodynamics, potentially affecting re-endothelialisation and long-term graft performance. Understanding flow behaviour within graft-treated aortas is therefore important for evaluating graft design.

This work investigates three-dimensional pulsatile flow in rigid, graft-treated thoracic aorta phantoms, which include the ascending aorta, aortic arch, descending aorta, and major aortic branches. The aim is to assess how graft geometry, specifically differences in branch angles and diameters, influences flow division, secondary flow structures, and local shear conditions.

Idealised rigid aortic phantom geometries were designed using dimensions representative of clinically used branched vascular grafts and manufactured using the lost core casting method with Sylgard 184. A Newtonian blood analogue seeded with polyamide particles (125 - 150 μm) was formulated to match the refractive index ($n = 1.4139$) of the phantoms, enabling optical flow measurements. A pulsatile pump was used to produce a physiological aortic waveform, and outlet-specific resistances were applied to achieve realistic flow distribution between branches. Particle tracking velocimetry (PTV) was employed to capture time-resolved, three-dimensional velocity measurements of individual tracer particles throughout the cardiac cycle.

The PTV results show that at Reynolds numbers representative of peak systole ($Re = 3400$), leakage flow ($Re = 140$), and reverse flow ($Re = 225$), graft geometry has a strong influence on flow division, recirculation regions, and local shear distributions. Differences in branch angle and diameter were found to modify secondary flow structures within the aortic arch, leading to distinct haemodynamic behaviour across graft configurations. These findings identify flow features in graft-treated aortas that may be unfavourable for re-endothelialisation and long-term graft performance.

This study provides experimental insight into pulsatile haemodynamics in graft-treated aortic models using PTV. The findings improve understanding of geometry-driven flow behaviour in vascular grafts, inform graft design and assessment, and provide a valuable experimental comparator for validating computational fluid dynamics models used in the design and regulatory assessment of vascular grafts.

009**TADCT Sponsored Session: Aortic Haemodynamics and Mechanics****Thursday 3 September 2026** · 13:00-14:00 · Space Six
Chairs: Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Experimental investigation of patient-specific false lumen haemodynamics and thrombosis progression in Type B aortic dissection

Mr Anastasios Koulogiannis, Professor Hendrik Von Tengg-Kobligh, Professor Stavroula Balabani, Professor Vanessa Diaz

Scheduled presenter: Mr Anastasios Koulogiannis · **Organisation:** University College London · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 207

DESCRIPTION OF PROPOSED TALK

Type B aortic dissection (TBAD) is associated with the development of a false lumen whose haemodynamics are known to significantly influence aneurysm development and rupture risk, as well as thrombosis. However, the exact flow mechanisms underpinning these processes within the false lumen are not well understood due to its complex geometry and fluid structure interaction.

Using compliant phantoms of a patient-specific TBAD geometry with a single primary entry tear and time-resolved particle image velocimetry (PIV) we have shown the formation of a high-velocity systolic jet entering the FL through the tear and impinging on the opposite wall, generating strong rotational flow within the proximal false lumen. This was accompanied by flow reversal during diastole leading to increasingly chaotic flow patterns. The absence of an exit tear resulted in gradual false lumen pressurisation, persistent recirculation, and low-velocity regions further downstream that are potentially associated with thrombus formation. Haemodynamic markers including false lumen ejection fraction, flow reversal, and wall motion were quantified, highlighting the importance of wall compliance and patient-specific geometry on FL haemodynamics.

Building on this work the present study investigates a more complex patient-specific TBAD case containing both an entry and an exit tear for which CT and 4D flow MR scans spanning a period of seven years after the initial dissection were available. The clinical data show progressive thrombus formation within the FL; thrombus initially concentrated near the entry tear, followed by progressive extension along the remaining false lumen length during later stages of the disease.

Patient-specific geometries reconstructed from the different imaging stages are being used to investigate how changes in false lumen flow structures correlate with thrombus progression. Current analysis focuses on quantifying haemodynamic features such as flow stagnation, residence time, recirculation, and washout, and comparing these with the observed thrombus distribution from the clinical imaging data. The objective is to develop haemodynamic indices capable of identifying regions susceptible to thrombosis and evaluate their predictive capability against patient-specific thrombus progression.

This work highlights the potential of combining patient-specific experimental haemodynamics with clinical imaging to improve understanding of thrombosis progression in TBAD and contribute towards the development of predictive tools for patient-specific risk assessment.

009**TADCT Sponsored Session: Aortic Haemodynamics and Mechanics**

Thursday 3 September 2026 · 13:00-14:00 · Space Six
Chairs: Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

AortaCFD: an automated open-source pipeline for reproducible patient-specific aortic haemodynamics

Dr Jie Wang, Dr Emily Manchester, Dr Dania Ahmed,, Prof Alistair Revell

Scheduled presenter: Dr Jie Wang · **Organisation:** Univeristy Of Manchester · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 229

DESCRIPTION OF PROPOSED TALK

Introduction

. Patient-specific computational fluid dynamics (CFD) provides non-invasive estimates of wall shear stress (WSS), oscillatory shear index (OSI) and trans-aortic pressure drop, with growing clinical relevance for Marfan syndrome, coarctation and aneurysm follow-up. Routine translation is held back not by the solvers themselves but by the expertise required to assemble a working case: mesh ules, scheme selection, solver tolerances and Windkessel parameter derivation are configured manually and rarely documented. The 2012 ASME CFD Challenge demonstrated that 28 expert groups given identical geometry produced consistent pressure drops but widely varying secondary-flow predictions, traceable to undocumented modelling choices. ASME V&V 40 guidance and emerging cardiovascular digital-twin frameworks now demand auditable, provenance-tagged workflows that current GUI-based platforms only partially provide.

Methods

. We present AortaCFD, an open-source pipeline built on OpenFOAM 12 that takes a patient STL surface and a single JSON configuration file as input and returns TAWSS, OSI and pressure-drop fields. The pipeline automates geometry pre-processing, mesh generation (single-parameter cells-per-diameter control with snappyHexMesh boundary layers), boundary-condition setup (adaptive inlet profiles from 4D flow MRI, Doppler or literature; three-element Windkessel outlets sized via Murray's law with a custom backflow-stabilised velocity boundary), solver execution under three preset numerical profiles (robust / standard / precise) and deterministic post-processing. Validation spans six cases: a healthy aorta with 4D flow MRI, a Marfan-syndrome aorta cross-checked against SimVascular, and a coarctation geometry for grid-convergence and physics-model sensitivity (laminar / k- ω SST / WALE LES).

Results

. Cross-solver validation against SimVascular yields pressure-waveform agreement $R > 0.95$ and diastolic pressure within 4%. Velocity-component correlation against 4D flow MRI reaches $R = 0.75-0.86$. Pressure-based quantities are stable across numerical profiles ($\pm 2\%$); WSS metrics carry larger, geometry-specific sensitivity ($>30\%$ combined mesh-and-scheme), in line with prior community findings. Backflow stabilisation (tangential dissipation $\beta_T = 0.3$) liminated diastolic Windkessel divergence in tested configurations with $<1\%$ haemodynamic bias. End-to-end case setup is reduced from hours of expert OpenFOAM configuration to minutes of JSON editing.

Discussion

. AortaCFD lowers the entry barrier to reproducible aortic CFD while preserving full numerical provenance. Released with 2,147 automated tests (83% code coverage) under a permissive licence, it offers a transparent baseline for aortic-disease research and a substrate for downstream digital-twin and in-silico clinical-trial workflows.

009**TADCT Sponsored Session: Aortic Haemodynamics and Mechanics****Thursday 3 September 2026** · 13:00-14:00 · Space Six
Chairs: Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Optimising polymeric heart valves for clinical translation through engineering approaches

Dr Joanna Stasiak, Dr Bilal Mughal, Prof Geoff Moggridge, Prof Raimondo Ascione, Dr Marta Serrani

Scheduled presenter: Dr Marta Serrani · **Organisation:** Durham University · **Programme slot:** 13:50-14:00 · **Order:** 6 · **Paper:** 89

DESCRIPTION OF PROPOSED TALK

Polymeric heart valves represent a promising alternative to mechanical and bioprosthetic valves, offering improved durability without the need for lifelong anticoagulation. A few devices have now reached preclinical and early clinical stages. Among these, valves made of styrenic block copolymers (SEBS) have exhibited superior in vitro durability, together with excellent biocompatibility in six-month sheep study.

These valves are unique in replicating the native tissue microstructure: during injection moulding, stiff styrene nano-cylinders are oriented within the polymer, producing anisotropic mechanical behaviour similar to that of collagen fibres.

To support clinical translation, we used computational modelling to optimise valve design and manufacturing. First, we investigated the effect of injection moulding on valve durability by combining micro-CT imaging with finite element analysis. Micro-CT scans of three valve prototypes from the same batch were acquired with a Xradia Versa XRM-410 microscope and reconstructed into three-dimensional geometries using Synopsys SimpleWare; the reconstructed geometries were compared with the nominal design using the Hausdorff distance. Computational models of both nominal and reconstructed valves were implemented in ABAQUS to simulate valve closure under a pressure of 100 mmHg. The results identified warpage as the primary manufacturing defect. Valves with greater geometric distortion exhibited higher maximum strain energy density (SED), a key predictor of material fatigue and device lifetime.

Second, we examined the influence of stent stiffness on valve performance. While a certain degree of flexibility can reduce peak leaflet stresses, excessive deformation may induce leaflet twisting and uneven load distribution. A finite element model was developed to evaluate different stent designs incorporating polymeric inserts of varying height and thickness. Simulations showed that more flexible stents reduce regurgitation during closure but increase leaflet SED, indicating a trade-off between hemodynamic performance and durability.

Overall, this study highlights the importance of controlling manufacturing-induced defects and carefully tuning stent stiffness to improve the performance and longevity of SEBS-based polymeric valves.

O10**AI in Health and Digital Twins: clinical decision support and personalised modelling****Thursday 3 September 2026** · 13:00-14:00 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan**Data-driven in silico clinical trials illustrated through the management of patients with atrial fibrillation**

Yun Bing, Wahbi El-Bouri

Scheduled presenter: Dr Yun Bing · **Organisation:** University of Liverpool · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 134**DESCRIPTION OF PROPOSED TALK**

Atrial fibrillation (AF), characterised by irregular and often rapid heart rhythm, is a highly prevalent condition and a major contributor to mortality. Management of AF is complicated by the presence of multimorbidities, such as hypertension, heart failure, and diabetes, that are also dynamic in nature. Aiming to improve the diagnosis, treatment, and management of AF, ARISTOTELES [1], a Horizon Europe project, integrates AI-driven solutions into clinical care to enable early risk predictions and personalised treatment decisions. As part of the project, we aim to develop an in silico clinical trial (ISCT) to compare the management of AF patients with the support of an AI-risk tool versus the usual-care.

ISCTs have recently emerged as a promising computational method for investigating and assessing novel medical interventions. The design of our ISCT consists of three components: virtual population (VPop), treatment assessment, and outcome prediction. A VPop, consisting of longitudinal patient health records, is first generated to be statistically indistinguishable from the real population. Being computational simulations, each virtual patient (VP) can serve as their own control, thus allowing different stratification methods to be compared within an individual. Every VP is then assigned treatments through two parallel care pathways: one informed by the AI-risk tool and the other reflecting routine clinical practice. Finally, treatment outcomes are predicted to assess the efficacy of the AI-risk tool.

To realise the ISCT, we employ a machine learning method called neural stochastic differential equations (SDEs) [2], where both the deterministic and stochastic terms are parameterised by neural networks. In this model, discrete records of a patient are assumed to be incomplete observations of an underlying health state that evolves continuously over time [3]. Longitudinal electronic health records of over 240,000 patients from five European countries are used to train the model. Observations (e.g., demographics, comorbidities, and labs) and treatments are encoded separately into the latent space as the latter is used as explicit controls. Within the latent space, a generative SDE is trained alongside a posterior SDE via variational inference. The hidden state is then reconstructed back to the observational space through a decoder. Once trained, the generative SDE can be solved given an initial state to create the VPop and predict future patient trajectories based on different treatments. The ISCT will parallel a real-world prospective randomised controlled trial, run as part of the ARISTOTELES consortium, for validation.

O10**AI in Health and Digital Twins: clinical decision support and personalised modelling****Thursday 3 September 2026** · 13:00-14:00 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan**Towards Haemodynamic Signatures of Pre-Eclampsia Across Gestation Using Maternal Digital Twins**

Dr Ioannis Polydoros, Dr Dale Kernot, Dr David O'Connor, Dr Mark White, Dr Kathryn Hunt, Dr Rosemary Townsend, Professor Rebecca Reynolds, Professor Hari Arora, Professor Raoul van Loon

Scheduled presenter: Dr Ioannis Polydoros · **Organisation:** Swansea University · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 160

DESCRIPTION OF PROPOSED TALK

Pre-eclampsia affects approximately 5% of pregnancies and remains a leading cause of maternal and perinatal morbidity. Standard clinical measurements such as blood pressure and cardiac output fail to capture the full haemodynamic complexity that distinguishes pre-eclampsia from related conditions. Personalised computational modelling offers a systematic, non-invasive route to investigating these alterations, one that complements and extends what is measurable in clinical practice and holds potential for guiding future haemodynamic biomarker development.

This study presents a maternal digital twin (mDT) framework combining personalised 1D/0D cardiovascular models with systematic waveform feature extraction. Thirty-six patient-specific models were constructed for two clinical cohorts: an early gestation group (n=21; 20-24 weeks) comparing women with chronic hypertension against those who developed pre-eclampsia, and a late gestation group (n=15; 34-39 weeks) comparing healthy pregnancies against women with pre-eclampsia. Models were personalised using routine clinical measurements including cardiac output, blood pressure, heart rate, pulse wave velocity, and uterine artery velocities.

A heart rate sweep (50-120 bpm) was applied to each model as a controlled cardiovascular perturbation, an approach analogous to standard system identification techniques in engineering. Pressure and flow waveform morphology features were extracted across six arterial locations spanning central to peripheral vessels, including the spiral arteries of the placenta, and assessed through statistical analysis. A composite feature-based score was then constructed by integrating and weighting features across vascular regions and heart rate states, providing a single quantitative index of cardiovascular deviation per patient.

The heart rate sweep revealed haemodynamic signatures that varied with physiological state and would not be accessible from measurements taken at a single time point. Distinct spatial and feature-type patterns emerged between cohorts, consistent with the recognised distinction between early-onset pre-eclampsia, driven predominantly by impaired uteroplacental remodelling, and late-onset disease, associated with maternal systemic cardiovascular dysfunction. The composite feature-based score showed improved group separation compared to standard clinical measurements in both cohorts.

This work demonstrates the feasibility of the mDT framework as a scalable computational tool for investigating pregnancy complications. Importantly, it establishes a foundation for future large-scale studies targeting computational biomarker development, with the potential to improve clinical risk stratification in pre-eclampsia and related pregnancy disorders.

O10**AI in Health and Digital Twins: clinical decision support and personalised modelling****Thursday 3 September 2026** · 13:00-14:00 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan**Clinical decision-node mapping as a pre-modelling framework for medical digital twin design**

Mr TJ O'sullivan

Scheduled presenter: Mr TJ O'sullivan · **Organisation:** University of Liverpool · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 161**DESCRIPTION OF PROPOSED TALK**

Clinical decision-node mapping as a pre-modelling framework for medical digital twin design

Introduction

Medical digital twins have growing potential to support personalised medicine by combining patient-specific data, computational modelling and simulation to inform clinical decisions. However, medical digital twin development starts with available models, data sources or technological frameworks. Although clinical workflow and patient-journey approaches are emerging, there remains a need for functional frameworks that can help identify where digital twins should be positioned within real clinical pathways before the design of the model begins.

Methods

We developed a pathway-first framework for identifying clinically meaningful decision nodes, where digital twins may be able to provide support before model development. The framework begins with a visual, flowchart-style mapping of a clinical pathway, rather than selecting the model architecture first. Key decision points are then identified and assessed for how suitable they would be for digital twin support. Suitability was considered using clinical uncertainty, patient-specific variability, availability of clinical data, and whether any prediction, simulation or dynamic updating was going to be useful. This approach aims to ensure that model development is guided by a clear clinical decision, rather than retrospectively fitting a digital twin to a pathway after development. It therefore works to bridge patient need and clinical reasoning with technology and design.

Results

The framework was applied to a clinician-reviewed atrial fibrillation pathway, mapped as a branching visual flowchart from diagnosis through treatment selection, stroke prevention and long-term follow-up. Atrial fibrillation was selected as a case study because its management involves many different risk-based and patient-specific decisions across a clear pathway. Use of the framework identified five potential decision nodes: anticoagulation initiation, rate vs rhythm control, rhythm-control intervention selection, anticoagulation reassessment, and follow-up scheduling. These nodes show how mapping the pathway can reveal different forms of potential DT support, including risk prediction, treatment comparison modelling, reassessment and personalised follow-up planning.

Conclusion

This pathway-first approach provides a flexible method for guiding medical digital twin design with real clinical decision-making. By identifying decision nodes before designing the model, the framework may help to develop digital twins around specific, defined clinical problems. This would improve clinical applicability, personalisation and is transferable into other complex disease pathways beyond just atrial fibrillation.

O10**AI in Health and Digital Twins: clinical decision support and personalised modelling****Thursday 3 September 2026** · 13:00-14:00 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan**Hierarchical Morphological Analysis and Computational Modelling of the Human Kidney: Effects of Vascular Architecture on Glomerular Filtration Rate**

Dr Kaihong Wang, Dr. Yousef Javanmardi, Dr Yang Zhou, Dr Claire Walsh, Professor Ryo Torii, Professor Peter Lee

Scheduled presenter: Dr Kaihong Wang · **Organisation:** University College London · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 86**DESCRIPTION OF PROPOSED TALK**

The kidney plays a vital role in blood filtration and homeostatic regulation, and its vasculature is key to understanding renal function and pathology. Each kidney is supplied by several segmental arteries branching from the main renal artery, which perfuse distinct, non-overlapping regions of the renal parenchyma (Figure 1a). The number of segmental arteries varies between individuals and may reach up to 10 depending on intra-organ branching patterns [1]. Within each segment, arteries branch into interlobar, arcuate, and interlobular vessels extending into the renal cortex, ultimately giving rise to afferent arterioles that supply the glomeruli, the kidney's primary filtration units.

The renal vasculature exhibits substantial structural variability, characterised by differences in vessel number, Strahler order distribution, and branching angle. These features vary across individuals and are further influenced by anatomical location, ageing, and disease. Disruption of this vascular network, such as through segmental artery stenosis or surgical resection, can lead to regional ischaemia and impaired kidney function (Figure 1b). These changes are commonly associated with reductions in glomerular filtration rate (GFR), a key clinical indicator of renal performance. Computational fluid dynamics simulations provide a non-invasive way of assessing hemodynamics such as blood flow and pressure, enabling estimation of GFR [2]. However, hierarchical morphological analysis remains limited by the spatial resolution of conventional imaging modalities, which constrains accurate representation for fine-scale vasculature and reduces confidence in computational predictions.

Hierarchical phase-contrast computed tomography (HiP-CT) offers unprecedented imaging resolution and penetration depth [3-5], allowing detailed reconstruction of renal vasculature, including glomeruli and arterioles. Previous study has identified more than 10,000 segments and a maximum Strahler order of 9 from an intact human kidney at an imaging resolution of 25 μm [6]. Such high-resolution data provide a opportunity to investigate structural variations associated with disease and ageing. More recently, computational pipelines integrating HiP-CT with reduced-order haemodynamic models have demonstrated the feasibility of estimating GFR from vascular reconstructions, supporting future digital-twin approaches for kidney assessment [6].

In this study, we aim to investigate the vascular differences associated with anatomical location within the human kidney and subsequently assess their influence on glomerular filtration rate through computational modelling. High-resolution HiP-CT datasets were acquired from both the left and right kidneys of the same human donor at an isotropic resolution of 52.16 μm , enabling consistent anatomical comparison under matched imaging conditions. Furthermore, computational analysis is performed to evaluate the haemodynamic consequences of kidney resection and their impacts on GFR.

O10**AI in Health and Digital Twins: clinical decision support and personalised modelling****Thursday 3 September 2026** · 13:00-14:00 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan**Cataract Detection and Classification in Digital Camera Images using Convolutional Neural Networks**

Miss Ching Yan Hannah Kwok, Professor Yalin Zheng

Scheduled presenter: Miss Ching Yan Hannah Kwok · **Organisation:** University of Liverpool · **Programme slot:** 13:50-14:00 · **Order:** 6 · **Paper:** 205**DESCRIPTION OF PROPOSED TALK**

Cataract remains a leading cause of global blindness, characterised by the clouding of the lens in the eyes. Early diagnosis is severely bottlenecked by the requirements for clinical expertise and specialist ophthalmic hardware to obtain slit lamp or fundus images. In resource-constrained settings, this dependency results in systemic underdiagnosis, functional impairments and avoidable vision loss. Thus, the goal of this research is to present a novel shift in diagnostic accessibility by developing a deep learning driven framework optimised for binary detection and multiclass classification of cataract in standard digital camera imagery. Three advanced CNN architectures of ResNet50, DenseNet121 and MobileNetV2 were implemented and benchmarked through transfer learning to differentiate cataract stages in images of an eye. A key innovation is the CORAL (Consistent Rank Logits) ordinal loss function applied in multiclass classification to capture the biological continuum of cataract progression. To ensure clinical interpretability, Grad-CAM++ saliency maps were generated to visualise the internal grading mechanism of the models. This confirmed that the diagnostic focus remained consistently localised on the morphological markers of lens opacification.

The framework demonstrated strong performance across independent datasets using grouped K-fold cross-validation to ensure scientific rigour and reduce subject leakage. Binary screening achieved a 97.5% internal accuracy and a competitive 89.6% accuracy in the external dataset. The ordinal multiclass model also demonstrated promising generalization to actual practice with a 97.1% internal and 76.6% external validation accuracy across disjoint datasets. Furthermore, the lightweight MobileNetV2 model achieved performance comparable to larger models, supporting future smartphone-integrated deployment. These results pushed boundaries in ophthalmic deep learning by providing a promising and feasible alternative for clinical diagnosis and grading without medical-grade imaging. This research provides a scalable path to affordable screening programs and offers a viable solution to mitigate global blindness through early, accessible intervention.

O11**Tissue Engineering I: scaffolds and regenerative platforms****Thursday 3 September 2026** · 13:00-14:00 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth**Cell Shape Confinement Promotes Junction Formation in Cultured Human Schlemm's Canal Endothelial Cells**

Mr Haoyu Xia, Jacques A. Bertrand, W. Daniel Stamer, Vania M. M. Braga, Darryl R. Overby

Scheduled presenter: Mr Haoyu Xia · **Organisation:** Imperial College London · **Programme slot:** 13:00-13:10 · **Order:** 1 · **Paper:** 83**DESCRIPTION OF PROPOSED TALK**

Impaired aqueous humor drainage via the conventional outflow pathway tissues leads to dysregulated intraocular pressure (IOP), a major risk factor for glaucoma. The inner wall endothelium of Schlemm's canal forms the sole continuous barrier to conventional outflow. A major limitation is that cultured Schlemm's canal endothelial cells (SCECs) do not establish mature cell-cell junctions and fail to recapitulate in vivo inner wall barrier function. In this study, we aim to restore lost barrier function in cultured SCECs by testing the strategy of cell shape confinement.

Primary SCECs isolated from 1 glaucomatous and 2 non-glaucomatous human donors were cultured on biotinylated gelatin-coated substrates to allow avidin labelling of sites of high permeability [1]. The coated substrate was either further processed to create micropatterns [2] that spatially confine cell attachment area or used without micropatterning to allow unconfined cell attachment and spreading. SCECs were exposed to fluorescent avidin prior to fixation. Samples were then immunolabelled for ZO-1 and/or pan-cadherin.

When confined to 80 µm circular micropatterns, a prominent band of ZO-1 immunolabelling was observed in most SCEC doublets across both glaucomatous (65% of 56 doublets, gSC57) and non-glaucomatous strains (66% of 83, SC60; 69% of 167, SC68). When ZO-1 was present, pan-cadherin was also present in all cases. When confined to 140 µm circular micropatterns, monolayers of 6-10 SCECs were observed, with prominent ZO-1 labelling along all cell-cell interfaces. In contrast, when SCECs were allowed to spread freely without confinement, peripheral ZO-1 and pan-cadherin labelling was punctate and discontinuous, with higher cytoplasmic background. Extensive labelling of fluorescent avidin was observed between neighbouring cells in unconfined SCECs, consistent with immature junction status. On micropatterns of either size, very little tracer labelling was observed between SCECs, indicating partial restoration of barrier function.

We have shown that cell shape confinement promotes cell-cell junctions and barrier function in cultured SCECs. Combining micropatterning and permeability mapping provides an opportunity to screen for compounds that modulate Schlemm's canal barrier function as potential outflow-enhancing drugs to lower IOP in glaucoma.

O11**Tissue Engineering I: scaffolds and regenerative platforms****Thursday 3 September 2026** · 13:00-14:00 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth**HIGH-THROUGHPUT VASCULARIZED MICROPHYSIOLOGICAL SYSTEMS FOR PROXIMAL TUBULE MODELLING**

Miss Mingying Han, Prof. Jude Curran, Prof. Patricia Murray, Dr. Ruoxiao Xie

Scheduled presenter: Miss Mingying Han · **Organisation:** University of Liverpool · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 97**DESCRIPTION OF PROPOSED TALK**

Microphysiological systems (MPS) recreate key aspects of human tissue microenvironments, enabling physiologically relevant studies of disease mechanisms and drug responses [1]. Incorporating vascular networks is crucial for sustaining tissue functionality and realistic drug transport [2]. However, current vascularized MPS are limited to simultaneously achieve high resolution, reproducibility, and throughput. Here, we present a projection printing-based strategy to enable the scalable fabrication of high-resolution vascularized MPS for proximal tubule modelling and aim to explore their applications in the in-vitro, high-throughput testing of drug metabolism and toxicity, thereby advancing preclinical drug screening.

By integrating a 384-well-compatible open-well architecture, sacrificial-template-assisted fabrication strategy and projection bioprinting, we enable the rapid and reproducible generation of perfusable microchannels with dimensions down to $\sim 100\ \mu\text{m}$ approaching the physiological scale of human proximal tubules in MPS. A 384-well-compatible open-well bioreactor was designed to facilitate straightforward medium handling and ensure compatibility with standard high-throughput workflows. Furthermore, to ensure structural fidelity without compromising biological activity, we engineered a hybrid bioink that minimizes hydrogel swelling and maintains excellent photoreactivity, printability, and long-term structural stability while providing an inductive microenvironment for cell proliferation and maturation. The printed MPS successfully supports the formation of robust epithelial and endothelial luminal architectures using conditionally immortalized proximal tubule epithelial cells (ciPTECs) and endothelial colony-forming cells (ECFCs). Crucially, immunofluorescence imaging confirmed the pronounced expression of hallmark barrier proteins, including ZO-1 in epithelial tubules and CD31/CD144 in vascular channels, which indicates high phenotypic maturity and junction formation.

Building upon these established architectures, our ongoing efforts focus on integrating these components into a parallelized epithelial-endothelial co-culture system. We are conducting quantitative functional validations, including barrier integrity permeability assays, renal tubule reabsorption profiling, and high-throughput nephrotoxicity screening. Ultimately, this work will provide a highly scalable and physiologically relevant framework for the in vitro modeling of vascularised tissues for high-throughput drug testing.

O11**Tissue Engineering I: scaffolds and regenerative platforms****Thursday 3 September 2026** · 13:00-14:00 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth**Building a physiologically relevant tendon on-a-chip in vitro model**

Mr Simon Konig, Dr Simon Grossemy, Dr Luke Philbrookes, Ms Catrin Bevan, Prof Hazel Screen, Dr Nidal Khatib

Scheduled presenter: Dr Simon Koenig · **Organisation:** Queen Mary University of London · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 98**DESCRIPTION OF PROPOSED TALK****Introduction**

Physiologically relevant in vitro tendon models remain limited, restricting investigation of tendinopathy. Proteomics identify two compartments: a dense, aligned collagen I-rich fascicular matrix (FM) and a softer, disorganised proteoglycan-rich interfascicular matrix (IFM) (1). Transcriptomics reveal compartment-specific tenocyte subpopulations (2) with differential mechanosensitivity and injury responses (3, 4), indicating distinct roles in tendon physiology and disease. Accordingly, we aimed to define the cellular, biochemical, and biophysical parameters required to inform design of a multi-compartment tendon in vitro model within a commercially available organ-on-a-chip platform such as the Emulate Chip-A1.

Methods

Distinct tenocyte populations were isolated via either utilisation of the IFM-associated marker PDGF-R α using FACS in bovine digital flexor tendon digests, or through enzymatic sequential digestion of rat tail tendons. Cells were characterised for morphology, tenogenic and extracellular matrix (ECM) marker expression, and mechanosensitivity with culture on tissue culture plastic (TCP) or polydimethylsiloxane (PDMS) substrates spanning 20 kPa to 2.5 MPa.

Native rat tail tendon and bovine IFM and FM mechanics were quantified by nanoindentation and rheology to guide biomaterial selection. Mechanical data informed development of stiffness-matched GelMA, fibrin, and Matrigel hydrogels for IFM cell culture. FM cells were cultured on TCP or aligned polyacrylonitrile nanofibers. Gene expression was assessed.

Optimised IFM- and FM-mimetic materials seeded with tenocytes were integrated into a layered construct within a mechanoactive organ-on-a-chip. Cell morphology, viability, and gene expression were assessed under mechanical stimulation, and fiducial-based strain mapping quantified load transfer.

Results

PDGF-R α ⁺ cells exhibited rounded morphology and increased Decorin and Versican expression, consistent with an IFM phenotype, whereas PDGF-R α ⁻ cells showed elevated Tenomodulin and collagen I, indicative of FM identity. Cells demonstrated mechanosensitivity, with softer substrates promoting IFM tenocyte proliferation, morphology, and gene expression.

Nanoindentation and rheology confirmed distinct compartment stiffness (IFM: 2.1 kPa; FM: 12 kPa). Stiffness-matched hydrogels modulated IFM gene expression, with all hydrogels increasing proteoglycan expression relative to TCP; Matrigel induced highest Vcan, Lum, and Prg4 expression. Col1a1 decreased overall, while Col3a1 and Tnxb increased only in Matrigel. FM cells showed modest substrate sensitivity, although aligned nanofibres increased Tnmd expression.

Within-chip analysis demonstrated strain transfer up to 6% within hydrogel compartments. Combined IFM and FM cultures exhibited altered gene expression in response to mechanical stimulation and niche-specific biomaterials.

Conclusion

These findings define the cell isolation strategies, compartment-specific stiffness parameters, and biomaterial combinations required to recapitulate IFM and FM niches in physiologically relevant, multi-compartment tendon-on-a-chip models to study mechanobiology and disease.

O11**Tissue Engineering I: scaffolds and regenerative platforms****Thursday 3 September 2026** · 13:00-14:00 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Experimental flow visualisation of the effect of bioreactor impeller geometries for cell culture applications

Miss Rebecca Lewis, Miss Eleanor Barton, Dr Joshua Lowe, Dr Ewan Ross, Dr Eirini Theodosiou, Professor Jean-Baptiste Soupez, Dr Patrick Geoghegan

Scheduled presenter: Miss Rebecca Lewis · **Organisation:** Aston University · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 101

DESCRIPTION OF PROPOSED TALK

The field of regenerative medicine requires vast quantities of cells, such as mesenchymal stem cells (MSCs); approximately 100 million per patient per dose. To obtain relevant cell quantities, stirred-tank bioreactors containing microcarriers are used to increase the efficiency of cell culture. The bioreactor's impeller promotes microcarrier suspension and homogeneity to improve both quality and quantity of expanded cells. However, it also creates shear stresses, which can cause undesirable differentiation or cell death. Therefore, optimum culture conditions require an impeller stirring speed which balances homogenisation with low shear stress generation. This study compares the geometrical influence of a commercially available impeller with a novel impeller design on velocity fields and shear stresses within a bioreactor to optimise bioreactor parameters for optimal MSC growth.

Sylgard 184 was used to cast a 1:1 scale model of a commercial 100 mL spinner flask. This model was refractive index matched with a working fluid seeded with hollow glass particles. The particles were illuminated with a laser light sheet and images were captured for planar particle image velocimetry measurements with phase-locked impeller positions. The flow behaviour at three stirring speeds relevant to laboratory operation of spinner flasks for MSC culture were investigated for both impeller designs.

Results

show that in comparison to the commercial impeller, the novel impeller creates regions of lower shear stress that could reduce unwanted effects on cells. The knowledge gained from this study can be applied to determining optimal bioreactor design for not only MSC culture but also other cell types, consequently helping to scale-up cell culture to meet the rising demand in regenerative medicine and other industries.

O11**Tissue Engineering I: scaffolds and regenerative platforms****Thursday 3 September 2026** · 13:00-14:00 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Estimating the Environmental Impact of Rodent Animal Facilities: A Preliminary Modelling Approach

Dr Francesco Giorgi

Scheduled presenter: Dr Francesco Giorgi · **Organisation:** University of Liverpool · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 104

DESCRIPTION OF PROPOSED TALK

The environmental impact of animal-based research remains largely underexplored, despite growing attention to sustainability within scientific practice and the recognised energy-intensive nature of these infrastructures. This study proposes a preliminary framework to estimate the carbon footprint of rodent animal facilities, with a focus on identifying key emission drivers. Based on literature analysis and system-level considerations, the main contributors to environmental impact were identified as heating, ventilation and air conditioning (HVAC), cage washing and sterilisation processes, and the use of consumables and waste management. Among these, HVAC systems emerge as the dominant driver, due to the continuous energy demand required to maintain strict environmental conditions for animal welfare and experimental reproducibility.

Building on these considerations, a simplified modelling framework was developed to provide researchers and facility managers with a practical tool to estimate emissions associated with animal facilities. The model prioritises robustness and applicability, relying on literature-derived data and standard emission factors. To provide a preliminary quantification of the magnitude of emissions associated with animal-based research, the model was applied to three hypothetical scenarios (small, medium, and large facilities) to explore variations in emission profiles. The results suggest that, although emissions increase with facility size and operational intensity, even small-scale animal facilities generate non-negligible emissions, comparable to those associated with several tens of average households or multiple passenger vehicles on an annual basis, highlighting the relevance of these infrastructures within the broader context of energy-intensive sectors.

These findings highlight the importance of incorporating environmental considerations into the design and management of research infrastructures. Furthermore, they support the integration of sustainability within the ethical framework of animal research, suggesting the inclusion of a potential “fourth R” alongside the classical 3Rs, aimed at promoting environmentally responsible research practices.

O11**Tissue Engineering I: scaffolds and regenerative platforms****Thursday 3 September 2026** · 13:00-14:00 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Cell Bandage for Human Corneal Epithelial Cell Transfer in PCED

Dr Hugo Moreiras, David E. Robinson, Nardine Menassa, Victoria R. Kearns, Rachel L. Williams, Hannah J. Levis

Scheduled presenter: Dr Hugo Moreiras · **Organisation:** University of Liverpool · **Programme slot:** 13:50-14:00 · **Order:** 6 · **Paper:** 149

DESCRIPTION OF PROPOSED TALK

Introduction

/Objectives: Persistent corneal epithelial defects (PCED) represent a major therapeutic challenge in ophthalmology. Patients with PCED are at increased risk of corneal ulceration, infection, perforation, neovascularisation, and scarring, frequently resulting in pain, discomfort, and progressive vision loss. Current standard-of-care treatments are often insufficient, leading to prolonged disease and poor visual outcomes. To address this unmet clinical need, we are developing a novel hydrogel-based cell bandage to deliver allogeneic human corneal epithelial cells (hCEpCs) directly to the ocular surface to treat PCED.

Methods

A methacrylated poly ϵ lysine (PeKMA) hydrogel was engineered, crosslinked with bis[sulfosuccinimidyl]suberate (BS3) before UV crosslinking, and functionalised with an RGD peptide sequence to support hCEpC attachment. Hydrogel physical properties were characterised by compressive modulus and handleability. Cytotoxicity was assessed both directly, by analysing hCEpC attachment and morphology on the hydrogels, and indirectly, by evaluating cell viability after exposure to hydrogel-conditioned media for 3 days. Cell delivery from the hydrogel to the ocular surface was evaluated using decellularised human corneal discs and ex vivo porcine eye models.

Results

The hydrogel supported robust hCEpC attachment, monolayer formation, and maintenance of epithelial phenotype, including expression of p63, a key marker of epithelial progenitor cells. Cell viability assays demonstrated that approximately 70% of cells retained normal metabolic activity. More than 60% of hCEpCs cultured on the hydrogels were successfully transferred to the surface of the corneal models within three days. Following transfer, cells remained proliferative for up to five days after removal of the bandage, contributing to epithelial regeneration.

Conclusions

This study presents a promising platform for cell-based therapy in PCED, enabling efficient delivery of a clinically relevant number of hCEpCs to the corneal surface. Ongoing and future work will focus on in vivo safety assessment in rabbit models to further evaluate the translational potential of this approach.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

Integrating Multi-omics and Machine Learning to Decipher AMD Pathogenesis

Mr Shixiang Yan, Prof Yalin Zheng, Dr Ceniz Zihni

Scheduled presenter: Mr Shixiang Yan · **Organisation:** University Of Liverpool · **Programme slot:** 14:00-14:02 · **Display:** Poster stand A · **Paper:** 21

DESCRIPTION OF PROPOSED TALK

Age-related macular degeneration (AMD) is a leading cause of irreversible central vision loss in the over 50s. While machine learning has made significant progress in improving early diagnostic accuracy, the underlying pathogenesis of AMD remains poorly understood, limiting the development of effective early interventions. Current treatments, such as anti-VEGF therapy to neutralize excess VEGF secretion by stressed retinal pigment epithelial cells (RPE), in neovascular AMD, can slow disease progression but cannot restore lost vision. In dry atrophic AMD, the most common form, there is no effective therapy. This highlights the need for a deeper understanding of its mechanisms. Increasing evidence suggests that complement system dysregulation associated with high-risk mutations identified in AMD patients, is closely related to the occurrence and development of AMD. Dysregulation of the alternative complement pathways is likely linked to mechanisms involved in inflammation, oxidative stress, and autophagy dysfunction in the RPE, through poorly characterized networks. Several publicly available multi-omics datasets provide an opportunity for large-scale research into these mechanisms. However, the integration of transcriptomic and proteomic data-linked to distinct genetic susceptibility mutations, to characterise how these mechanisms form complex networks to drive AMD progression, has not been determined.

This study proposes an integrated framework combining multi-omics data derived from AMD patients carrying distinct mutations and genetic variants within the complement pathway, and machine learning to identify the molecular driving mechanisms of AMD. As an initial step, publicly available RNA-sequencing datasets, from patients carrying high risk mutations, are being curated and processed to characterise transcriptional alterations associated with AMD. Preliminary work has focused on data harmonisation, quality control, and the identification of cell-type-specific expression patterns, focussing primarily on the RPE, relevant to retinal degeneration. Here, the analytical framework, data-processing pipeline, and preliminary transcriptomic observations derived from ongoing analyses of datasets will be outlined, to identify dysregulated immune and complement-related pathways, which will guide subsequent multi-omics integration.

By combining multi-layered molecular data with computational modelling, this work aims to advance our understanding of AMD pathophysiology and provide a foundational framework for more precise and effective early-stage interventions.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

Machine Learning Analysis of Bladder dysfunction

Ms Dheekshitha Sankar, Professor Michael Chappell, Panagiotis Tsakonas, Dr Brian Andrews, Dr John Reynard

Scheduled presenter: Ms Dheekshitha Sankar · **Organisation:** University Of Warwick - School Of Engineering · **Programme slot:** 14:02-14:04 · **Display:** Poster stand A · **Paper:** 69

DESCRIPTION OF PROPOSED TALK

Lower Urinary Tract Dysfunction (LUTD), including Overactive Bladder (OAB) and Underactive Bladder (UAB), affects up to 60% of adults over the age of 40, reducing the quality of life and placing significant burden on healthcare systems. Current clinical diagnosis relies on invasive pressure-flow studies (PFS) which can cause discomfort to the patient and can be resource-intensive. Furthermore, distinguishing between symptomatically similar conditions like Detrusor Underactivity (DU) and Bladder Outlet Obstruction (BOO) remains a significant clinical challenge. This project aims to develop a machine learning framework to non-invasively predict bladder dysfunction states. The research focuses on identifying Detrusor Overactivity (DO) and differentiating between DU and BOO by integrating biomechanical principles with data analytics.

The study evaluates two distinct methodologies using a publicly available urodynamic dataset released by the Second Affiliated Hospital of Kunming Medical University (Yang et al., 2023), namely: (i) Physics-Informed Neural Networks (PINN) that incorporate bladder contractility model equations developed by Griffiths; (ii) XGBoost Classification, a data-driven approach utilising non-invasive features including age, BMI (Body Mass Index), and IPSS (International Prostate Symptom Score) for automated pattern recognition. The PINN model integrated with the Classifier demonstrated the best performance, predicting detrusor dysfunction with an accuracy of 80% and specificity of 84.38%. The Area Under the Curve (AUC) of the model's Receiver Operating Characteristic (ROC) curve was 0.8667. While the XGBoost classifier achieved a modest overall accuracy of 68.18%, it demonstrated a high specificity of 85.19%, making it an effective "rule-out" tool for DU.

This research provides a robust foundation for non-invasive diagnostic tools. While co-occurring pathologies remain difficult to resolve with current features, the integration of physics-informed models and advanced signal processing offers a pathway toward effective, personalised, home-based monitoring devices that could significantly reduce clinical costs and patient invasiveness.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

Semi-Automatic Extraction of the Fetal Aortic Diameter Wave: A Machine Learning Approach

Mr James Ramm, Dr Raheleh Kafieh, Professor Asma Khalil, Professor Ashraf Khir

Scheduled presenter: Mr James Ramm · **Organisation:** Durham University · **Programme slot:** 14:04-14:06 · **Display:** Poster stand A · **Paper:** 78

DESCRIPTION OF PROPOSED TALK

M-mode ultrasound enables high temporal resolution assessment of fetal hemodynamics. However, image quality varies across clinical and acquisition conditions, including machine manufacturer, sonographer, and maternal factors, limiting automated analysis. This study presents a pipeline for extracting fetal aortic diameter waveforms from M-mode ultrasound and evaluates training strategies across image quality. We demonstrate that exposure to heterogeneous data outperforms curriculum-based approaches for robust segmentation. Accurate extraction of the waveform is essential for estimating non-invasive pulse wave velocity (PWV) [1], a key marker of fetal cardiovascular function, yet current approaches rely on time-consuming manual annotation.

A dataset of 93 M-mode DICOM recordings from 31 patients was stratified into high-, medium-, and low-quality subsets. Expert annotations of lumen-wall boundaries were generated within manually defined regions of interest (ROIs). Files were split into individual cardiac cycles, yielding 153 high-quality, 142 medium-quality, and 161 low-quality samples, with patient-level separation maintained across training, validation, and testing.

A U-Net architecture with a composite loss function was implemented for lumen segmentation. When trained on full images, segmentation performance was limited (mean error: 7.9 px, 6.7 px, 33.3 px for high-, medium-, and low-quality data, respectively), largely due to incorrect anatomical boundary selection. Incorporating expert-defined ROIs substantially improved accuracy (0.87 px, 1.6 px, 3.0 px).

To automate ROI selection, a two-stage pipeline using YOLOv8 followed by U-Net segmentation was developed. While this approach improved performance on medium-quality data, ROI misclassification in high- and low-quality images limited the overall accuracy.

Training strategies were evaluated with a fixed loss function and U-Net structure. The baseline consisted of training on all image qualities equally. Alternative approaches included quality-weighted loss functions, curriculum-based approaches [2], and training on specific quality subsets.

Across most strategies, performance differences were minimal, with the baseline model matching or outperforming complex approaches. Fine-tuning yielded marginal improvements on high- and medium-quality data (0.85 px and 1.56 px), while training on high- and medium-quality data achieved the lowest error for low-quality images (2.69 px). In contrast, multi-phase curriculum learning consistently degraded performance.

These findings indicate that exposure to the full distribution of image qualities is more beneficial than alternative training strategies, suggesting that robustness to ultrasound variability is better learned through data diversity than through curriculum design. Crucially, segmentation accuracy remained highly dependent on accurate ROI localization, identifying this as the primary bottleneck preventing fully automated analysis. Future work will focus on super-resolution preprocessing and improved ROI detection via multi-modal approaches.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

Algorithmic fairness in ICU outcomes: Analysis and mitigation of demographic bias in the MIMIC-Sepsis mortality prediction benchmark model

Miss Molly Lander, Dr Shahram Mohanna

Scheduled presenter: Miss Molly Lander · **Organisation:** University Of Bath · **Programme slot:** 14:06-14:08 · **Display:** Poster stand A · **Paper:** 103

DESCRIPTION OF PROPOSED TALK

The exact origin of racial imbalances in ICU sepsis outcomes remains uncertain [1], providing motivation to ensure these do not compound with algorithmic bias in AI, and lead to inequitable care that harms underrepresented clinical populations. The MIMIC-Sepsis in-hospital mortality prediction transformer model offers a promising global AUROC score of 0.863 [2], and acts as a benchmark for future works, but its performance across minority patient populations remains unexamined until now. Utilising a curated MIMIC-IV sepsis cohort of 35,021 patients, this study identified a critical gap in demographic representation with a 67.2% white clinical population. Fairness analysis employed the equalised odds criterion for group evaluation with additional insight into the impact on intersectional calibration and global accuracy. Pre-processing reweighting mitigation adjusted each sample's contribution to account for demographic imbalance in training data. Global and group-specific threshold tuning post-processing mitigation modified decision thresholds to reduce disparities in classification error rates. Baseline model analysis exposed a fairness violation between racial groups, with a TPR difference of 0.0678 between Asian and Latino patients. No significant disparities were displayed across administrative sex groups alone, but Latino women were exposed to the highest risk of missed mortality predictions, with the fairness gap enlarging to 0.1176 at the race-sex intersections. Group-specific threshold tuning proved most effective, reducing the fairness gap to 0.0114, below our 0.05 acceptable threshold, whilst only reducing global AUROC by 1.16% to 0.853, maintaining strong clinical utility. This study underscores the importance of actively detecting unintentional bias in future works and demonstrates the feasibility of bias mitigation in clinical models in practice.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

Design and Fabrication of an Ultra-Low Power Wearable Fall Detection System For the Elderly

Mr Aryan Ghosh

Scheduled presenter: Mr Aryan Ghosh · **Organisation:** University Of Bath · **Programme slot:** 14:08-14:10 · **Display:** Poster stand A · **Paper:** 118

DESCRIPTION OF PROPOSED TALK

Falls in the elderly represent a significant clinical challenge, often leading to long-term disability or fatal complications due to delayed assistance. While wearable fall detection systems exist, they are frequently limited by a binary trade-off: high-frequency sampling for accuracy leads to prohibitive power consumption, while low-power threshold-based systems suffer from high false-alarm rates (FAR), reducing user compliance.

This research presents an ultra-low power wearable that leverages the Machine Learning Core (MLC) of an STMicroelectronics LSM6DSV16X Inertial Measurement Unit (IMU). Unlike traditional architectures where a microcontroller (MCU) must remain active to process motion data or the IMU has a rudimentary interrupt that triggers from states of free fall followed by high impact, this approach offloads detection to a Decision Tree classifier embedded directly within the IMU's silicon. The model was trained using the SisFall dataset, with additional IMU recordings of various tasks to minimise false positives. As a show of further potential, a pulse oximeter is added to the device to record and log additional health data to possibly expand from just falls to other problems.

The device achieves a fall detection sensitivity of $>90\%$ while maintaining a theoretical battery life of approximately 12 days on a 1100mAh lipo cell. The on-sensor MLC allows the microcontroller to remain in deep-sleep until a hardware interrupt is triggered, reducing idle power draw.

This work demonstrates a scalable "edge-intelligence" approach to remote patient monitoring. By moving complex classification from the MCU to the sensor, we address the critical barrier of battery longevity in wearables. This innovation offers a path toward persistent, unobtrusive monitoring that improves rapid-response capabilities for caregivers while maintaining user privacy through local, on-device processing.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

Explainable Artificial Intelligence for the Assessment of Skin Lesions in Primary Care

Mr Brandon Ferral

Scheduled presenter: Mr Brandon Ferral · **Organisation:** Queen Mary University · **Programme slot:** 14:10-14:12 · **Display:** Poster stand A · **Paper:** 150

DESCRIPTION OF PROPOSED TALK

Early assessment of suspicious skin lesions in primary care remains clinically challenging, particularly because many benign lesions are referred through specialist pathways due to diagnostic uncertainty, limited dermatology training, and increasing pressure on dermatology services. Although deep learning models have shown strong performance in skin lesion classification, many systems remain difficult to interpret and often provide isolated probabilistic outputs that do not reflect the structured visual reasoning used by clinicians.

This project presents an explainable, image-based artificial intelligence framework designed to support the assessment of skin lesions through a multistage clinical reasoning pipeline. The system integrates automated image preprocessing, artefact reduction, skin and lesion detection, benign-malignant classification, lesion segmentation, benign subtype classification, and post-classification visual analysis. Rather than relying solely on a single classification score, the framework uses segmentation-centred analysis to assess lesion localisation, border definition, spatial consistency, and the presence of single or multiple lesions. Additional visual features, including dominant colour patterns and lesion geometry, are used to generate interpretable outputs related to asymmetry, border irregularity, colour variation, and diagnostic confidence.

The system is designed to produce clinician-readable results, including structured summaries of predicted lesion category, segmentation quality, border characteristics, colour features, and safety flags. Images with multiple lesions, inadequate segmentation, or insufficient visual confidence are flagged to avoid overconfident classification, supporting safer use in clinical decision-support settings. By mapping algorithmic outputs to recognisable dermatological reasoning patterns, the framework aims to reduce the gap between deep learning predictions and clinical interpretation.

This approach demonstrates the potential of explainable, multistage AI systems to improve transparency, support primary care decision-making, and contribute to reducing unnecessary benign referrals while maintaining a safety-focused workflow for suspicious lesions.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

From Cut-Points to Deep Learning: Robust Activity Classification Across Wrist Placements in Free-Living Accelerometry

Mr Vishnuvardhan Reddy, Dr. Alex V Rowlands, Dr Tim C Pearce

Scheduled presenter: Mr Vishnuvardhan Reddy · **Organisation:** University Of Leicester · **Programme slot:** 14:12-14:14 ·**Display:** Poster stand A · **Paper:** 49

DESCRIPTION OF PROPOSED TALK

Wrist-worn accelerometers are widely used to quantify free-living physical activity and sedentary behaviour, yet commonly used cut-point methods rely on fixed acceleration thresholds that are frequently applied across devices and wrist placements without revalidation. Large-scale population surveys further complicate this by adopting different wrist conventions such as dominant wrist versus non-dominant wrist making cross-cohort comparability of activity estimates a pressing methodological challenge. Although mean wrist-level activity estimates may appear comparable across groups, individual placement sensitivity can introduce >20% miscalculation of physical activity intensity which is a variance-level instability that aggregate comparisons routinely obscure and that is particularly consequential for individual-level clinical phenotyping. Self-supervised learning (SSL) is an approach that learns reusable activity representations from large quantities of unlabelled free-living accelerometer data without manual annotation. It may offer a more robust, transferable alternative to fixed cut-points, particularly in unscripted, heterogeneous free-living scenarios where activity distributions are highly variable and difficult to characterise with simple amplitude boundaries.

We conduct two complementary analyses comparing a GGIR pipeline applying published cut-points with ActiNet, a self-supervised DL model for wrist-based activity intensity classification. First, cut-point performance is benchmarked against annotated reference labels from CAPTURE-24, a large free-living accelerometer dataset. As ActiNet was fine-tuned on CAPTURE-24, a direct labelled comparison on this dataset would constitute internal validation and inflate learned model performance which itself is a finding about benchmark contamination that is underappreciated in the HAR literature. Preliminary results for cut-points yield a macro-F1 of 0.48, with sedentary time overestimated by +227 min/day and a light physical activity F1 of 0.32 - a boundary of critical clinical-relevance for cardiometabolic behaviour change. Second, both methods are applied to the CODEC dataset which is a well-characterised cohort of over 1,800 individuals with type 2 diabetes wearing a GENEActiv accelerometer on the non-dominant wrist where, in the absence of annotated ground-truth labels, evaluation shifts to inter-method output agreement, activity distribution shifts under wrist-placement transfer, and downstream associations with cardiometabolic health markers including HbA1c.

We hypothesise that fixed cut-point methods are more vulnerable than SSL-based models to wrist-placement transfer, producing greater output instability when deployed beyond their original calibration conditions. If learned models yield more stable behavioral-phenotyping across wrist placements, associations between physical activity and health outcomes such as glycaemic-control in T2DM may be more reliably detected and compared across large cohort studies where wrist placement conventions are inconsistently applied, with direct implications for both population health-surveillance and personalised health-insights.

P01**AI in Bioengineering****Thursday 3 September 2026** · 14:00-14:18 · Space One and Two**Chairs:** Professor Yalin Zheng · Dr Cameron Kirk

PathVLG: A Vision-Language Framework for Domain Generalization in Cross-Organ Adenocarcinoma Segmentation

Miss biwen meng, Mr Wanrong Yang, Mr xi long, Miss yuyao wang, Dr Kang Dang, Dr Yalin Zheng, Dr Jingxin Liu

Scheduled presenter: Miss biwen meng · **Organisation:** University of Liverpool · **Programme slot:** 14:14-14:16 · **Display:** Poster stand B · **Paper:** 121

DESCRIPTION OF PROPOSED TALK

Domain shifts in computational pathology, caused by variations in staining, imaging devices, and tissue morphology, challenge model performance in segmentation tasks. Existing domain generalization methods, such as style transfer and feature alignment, often fail to account for organ-level morphological differences. In this paper, we propose PathVLG, a vision-language model designed to improve domain generalization for adenocarcinoma segmentation. PathVLG leverages a CONCH-based encoder with three key innovations: the Text-informed Content Query Reformer (TCQR), Text-driven Style Augmentor (TSA), and Style Regeneration Decoder (SRD). These components help the model adapt across domains by incorporating text embeddings, generating diverse styles, and combining source and target domain features. Experimental results show that PathVLG outperforms existing methods in cross-domain generalization.

P02**Computational Modelling and Digital Twins****Thursday 3 September 2026** · 14:00-14:14 · Space Four**Chairs:** Professor Blanca Rodriguez · Dr Ahmed Abass

Finite element modelling of graft detachment mechanics in endothelial keratoplasty

Mr Rami Alanazi

Scheduled presenter: Mr Rami Alanazi · **Organisation:** University Of Liverpool · **Programme slot:** 14:00-14:02 · **Display:** Poster stand B · **Paper:** 15

DESCRIPTION OF PROPOSED TALK

Graft detachment remains a common complication following endothelial keratoplasty and is influenced by mechanical factors such as graft stiffness and air bubble tamponade. This study presents a finite element modelling framework to investigate graft-host contact behaviour under physiological intraocular pressure and posterior air bubble support.

A total of fifteen models were constructed using realistic anatomical geometry, varying graft stiffness (0.01-0.0001 MPa) and air bubble size. Key outputs included contact pressure (CPRESS), contact opening (COPEN), and contact ratio to quantify interface behaviour.

Results

showed that measurable graft-host contact occurred only in cases combining relatively high graft stiffness (≥ 0.005 MPa) with larger air bubble configurations. Time-dependent analysis demonstrated progressive increases in CPRESS and reductions in COPEN in these cases, while all other configurations exhibited persistent separation. Internal stress levels remained largely unchanged across simulations, indicating that interface mechanics, rather than bulk stress, govern detachment behaviour.

These findings provide a biomechanical interpretation of graft detachment patterns and highlight the combined role of graft properties and air bubble support in determining interface stability. While the model represents a proof-of-concept, it establishes a foundation for future patient-specific approaches integrating imaging data to support clinical decision-making in endothelial keratoplasty.

P02**Computational Modelling and Digital Twins****Thursday 3 September 2026** · 14:00-14:14 · Space Four**Chairs:** Professor Blanca Rodriguez · Dr Ahmed Abass

A voxel-based linear finite element model to predict proximal femur fracture in side-falls

Mr Jacob Wilkinson, Prof. Claire Brockett, Dr. Pinaki Bhattacharya

Scheduled presenter: Mr Jacob Wilkinson · **Organisation:** The University Of Sheffield · **Programme slot:** 14:02-14:04 ·**Display:** Poster stand B · **Paper:** 37

DESCRIPTION OF PROPOSED TALK

Background

Osteoporosis (OP) is responsible for ~520,000 fractures annually in the UK, of which ~20% are hip fractures [1]. However, these fractures account for >50% of spending on fragility fractures [1]. The finite element (FE) modelling based Computed Tomography to Strength (CT2S) method can classify fracture status with high accuracy [2]. A barrier to its clinical use is the need to reliably mesh the irregular femur volume with tetrahedra. In contrast, the FE solver ParOSol [3] uses a voxel mesh, reducing operator time. However, the CT2S failure assessment is not compatible with voxel mesh, thus, an alternative failure criterion is required.

Aim

Develop a voxel-based FE pipeline to determine neutral fall strength and verify results against the gold-standard CT2S method.

Materials and Methods:

Proximal femur CT scans of 86 patients from a previous study [2] comprising an equal split of fractured and non-fractured cases were used to create FE models with Cartesian axis-aligned meshes comprising 8-noded 1 mm cube (voxel) elements. Similar to [2], isotropic, linear elastic material properties, with heterogeneous (CT-derived) elastic moduli were specified; boundary and loading conditions were applied at the distal end, the surface of the femoral head and the greater trochanter, simulating neutral orientation fall loading; elements were considered to have failed if either maximum or minimum principal strains exceeded respective critical values (0.73% and -1.04% respectively). Differently to [2], fall strength was defined as the minimum force required for any contiguous region of failed elements to form occupying $5 \pm 0.1\%$ of the proximal femur volume and located anywhere within it, but away from boundary and loading condition application locations [4]. The FE models were analysed using ParOSol, and strength computation (post-processing) was performed using ParaView.

Results

The voxel-based pipeline predicted failed regions predominantly in the superior aspect of the femoral neck. It systematically underestimated the fall strength by ~45% ($R^2 = 0.68$) compared to CT2S. The area under the receiver operator characteristic curve (AUC) for classifying fracture status was 0.80.

Discussion

Failed regions predicted by the voxel-based pipeline agree with CT2S predictions and experimentally observed patterns. Despite the systematic error in strength, the fracture classification power was indistinguishable from CT2S.

Conclusion

Voxel-based linear models run using open-source software, have identical fracture classification power as tetrahedral models, with a simplified pre-processing approach. Optimisation of the voxel model failure criterion may improve the accuracy of the fall strength prediction.

Acknowledgements:

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P02**Computational Modelling and Digital Twins****Thursday 3 September 2026** · 14:00-14:14 · Space Four**Chairs:** Professor Blanca Rodriguez · Dr Ahmed Abass

In Silico Modelling of Microstructure-based Fluid Flow in Lymph Node

Mr Ralph Nehme, Prof Yuhang Chen, Dr Marta Peña Fernández

Scheduled presenter: Mr Ralph Nehme · **Organisation:** Heriot-Watt University · **Programme slot:** 14:04-14:06 · **Display:** Poster stand B · **Paper:** 87

DESCRIPTION OF PROPOSED TALK

The study of lymph node microstructure and fluid flow in silico has gained significant momentum over the past decade [1]. The lymph node system presents a unique computational challenge, combining free-flowing sinuses with porous cortical regions where exchange between lymphatic and blood fluids occurs. Previous models [2, 3] frequently rely on oversimplified geometries (particularly regarding medullary sinuses and high endothelial venules) and homogeneous material properties, thus failing to accurately represent physiological conditions or capture the complex physical behaviours of highly heterogeneous lymph node microstructures.

This study aims to develop a microstructure-based in silico model of the lymph node's vasculature and a more representative medullary sinus geometry to predict flow patterns and drug penetration. This will be done by capturing the advection-diffusion-reaction characteristics of the highly heterogeneous structure, helping in determining the necessary simulation parameters for an accurate representation of lymph node flow patterns.

MicroCT images of murine lymph nodes are reconstructed for the simulations, using a similar method applied by Jafarnejad et al. [4]. The imaging data is then segmented and rendered into a 3D microstructural model, then meshed and simulated in OpenFOAM. The sinus was modelled as a free-fluid region, whilst the cortical region was defined as a porous medium using the Darcy-Forchheimer equation for porous media. The afferent lymphatic vessel was set as a velocity inlet with a flow rate of 7.58×10^{-7} kg/s, and the efferent lymphatic set as a pressure outlet at 0 Pa [3]. Additionally, fluid exchange across the high endothelial venules was governed by Starling's principle, used to model the transvascular fluid flux. A parametric study will also be conducted on the cortical region, to determine the ideal permeability range using the greyscale intensity from the imaging data.

This model will provide a novel understanding of the fluid flow in heterogeneous microstructures of lymph nodes, serving as a robust platform for predicting how microstructural changes, driven by pathologies such as metastasis or chronic inflammation, alter fluid transport and function of lymph nodes. This can help offer critical insights for the development of targeted drug delivery systems and immunotherapies [5].

P02**Computational Modelling and Digital Twins****Thursday 3 September 2026** · 14:00-14:14 · Space Four**Chairs:** Professor Blanca Rodriguez · Dr Ahmed Abass

A Rapid Simulation Framework for Compression Garment Pressure and Soft Tissue Deformation

Mrs Olga Kravchenko

Scheduled presenter: Mrs Olga Kravchenko · **Organisation:** Imperial College London · **Programme slot:** 14:06-14:08 ·**Display:** Poster stand B · **Paper:** 133

DESCRIPTION OF PROPOSED TALK

Compression Garment (CG) design is a multivariable problem, spanning material mechanics, body geometry, and physical activity. However, the tools available to designers remain largely inherited from fashion, optimised for visual fit rather than performance. Physical user testing, while necessary, is time-consuming, lacks repeatability, and sensitive to participant pool size and morphology. This creates a design bottleneck: meaningful decisions require prototyping and testing cycles that are not feasible within normal development timelines, pushing designers toward assumption rather than evidence and compromising both mechanistic understanding and user outcome.

This talk presents a proposed parametric simulation framework for modelling CG pressure distribution and soft tissue deformation. The framework is built in Rhino, Grasshopper, and Kangaroo Physics - a constraint-based solver chosen for its stability under large deformations, computational speed, and suitability for modelling volume-preserving soft tissue behaviour under external compression. Fabric tension, garment fit, and variable material stiffness are represented through adjustable constraints, enabling simulation of zoned pressure configurations across different anatomical geometries without the setup complexity of finite element analysis.

Validation follows a structured, progressive methodology. Silicone soft tissue analogues, matched to published stiffness ranges for human soft tissue under compression, serve as physical benchmarks. Beginning with simple cylindrical geometries and increasing in complexity through elliptical and anatomical cross-sections representing calf and chest. Simulated pressure outputs are compared against physical measurements using pressure-sensitive film and surface contour imaging at each stage. The goal is not to replace physical testing entirely, but to front-load design understanding so that fewer, better-informed prototypes are needed.

This research sits at the intersection of computational design, soft tissue mechanics, and performance apparel, with applicability across sportswear, medical compression, and wearable technology.

P02**Computational Modelling and Digital Twins****Thursday 3 September 2026** · 14:00-14:14 · Space Four**Chairs:** Professor Blanca Rodriguez · Dr Ahmed Abass

Image Based Risk-Aware Path Planning for Robotic Steerable Needle Biopsy

Miss Jingyi Pei, Prof Zion Tse

Scheduled presenter: Miss Jingyi Pei · **Organisation:** Queen Mary University of London · **Programme slot:** 14:08-14:10 ·**Display:** Poster stand B · **Paper:** 184

DESCRIPTION OF PROPOSED TALK

Needle biopsy is widely used for diagnosing deep seated lesions, but accurate targeting remains challenging when the insertion path passes near vessels or organ boundaries. Haemorrhage is the most common severe complication of percutaneous liver biopsy, with reported rates of moderate to severe bleeding ranging from 0% to 5.3% [1]. Recent advances have demonstrated autonomous steerable needle navigation in living tissue [2], yet trajectory selection still relies largely on geometric accessibility and operator experience. Existing planning methods focus on obstacle avoidance and certifiable optimality [3] or force-aware tissue damage reduction [4], but few explicitly quantify cumulative anatomical risk along the entire trajectory.

This work presents a risk-aware path planning method for robotic steerable needle biopsy that prioritises safety over path length alone. Segmented anatomical structures from pre-operative images are converted into a spatial risk map with exponentially decaying distance weighted costs near vessels, organ boundaries, and restricted zones. Unlike sampling based planners that treat vessels as binary obstacles, this continuous risk field enables explicit trade off between path length and cumulative risk exposure. Candidate trajectories are evaluated by a composite objective balancing path length, accumulated risk, minimum vessel clearance, and curvature feasibility consistent with bevel tip needle kinematics [5].

The method was evaluated on a two dimensional synthetic liver scenario with realistic vessel spacing (8-15 mm) and ten vessels of varying diameter (1.4-3.5 mm). The risk-aware trajectory achieved a 40% reduction in accumulated risk score and increased minimum vessel clearance from 0.6 mm to 1.5 mm, at the cost of a 25% increase in path length (87 mm vs. 69 mm).

These results demonstrate the feasibility of incorporating patient specific anatomical risk into robotic biopsy planning. By reducing the likelihood of vessel puncture, this approach could lower complication rates and support less experienced operators in selecting safer trajectories. This module forms the first of three objectives in a program developing a closed-loop MRI-guided continuum robot assisted steerable needle system, with subsequent work targeting real time needle tip tracking and control under imaging feedback. If validated on clinical data, the framework could be integrated into existing image guided intervention platforms as a semiautonomous planning tool.

P02**Computational Modelling and Digital Twins****Thursday 3 September 2026** · 14:00-14:14 · Space Four**Chairs:** Professor Blanca Rodriguez · Dr Ahmed Abass

An online database to standardise patient-specific airway dimensions estimates

Mr Raza Ali Sarwar

Scheduled presenter: Mr Raza Ali Sarwar (Dr Himanshu Kaul) · **Organisation:** University Of Leicester · **Programme slot:** 14:10-14:12 · **Display:** Poster stand C · **Paper:** 186

DESCRIPTION OF PROPOSED TALK

Introduction

Asthma represents a critical area within human biology that affects ~260 million people globally. Precision medicine is a potentially powerful solution, but it requires patient-specific understanding of the mechanisms that mediate airway remodelling [1]. This requires precise, patient-specific airway dimension estimates on which the relevant biophysical equations could be solved. However, there is a lack of consensus on geometric regimes that are physiologically plausible.

Aim

s: Identify physiologically plausible airway dimension estimates and make them available via open-access online database to standardise lung modelling.

Methods

We first gathered datasets reporting dimensions of healthy and diseased airways published over the last four decades. Then we standardised the airways based on the Horsfield order. We next screened geometries by ensuring physiological coherence achieved by simulating a lung function model [2]. Finally, we constructed a tech stack consisting of Python, Django, JavaScript and CSS to share the standardised, clinically relevant airways.

Results

The standardised geometries were made available via online database where authenticated users can upload, preview or download the data. Authenticated users can upload their own airway dimension data that will be automatically standardised through a biophysical equation. The database then further conducts a Principal Component Analysis followed by unsupervised clustering. Uploaded datasets will be made available following verification by the system administrator. Users can therefore test whether their dimension estimates are physiologically relevant. Modelers can download standardised data for conducting simulations [2]. Users are also able to check if the final results are similar to other results through graphical visualisation.

Conclusion

We report that published airway dimension estimates show methodological variability that impact lung function predictions. We overcame this challenge by identifying physiologically plausible estimates and created a database to make those estimates broadly available. We anticipate the database will standardise lung modelling practice, improve accuracy of personalised predictions and scale deployment of precision medicine strategies.

P02**Computational Modelling and Digital Twins****Thursday 3 September 2026** · 14:00-14:14 · Space Four**Chairs:** Professor Blanca Rodriguez · Dr Ahmed Abass

From Images to Insight: AI and Digital Twins for Retinal and Systemic Diseases

Mr Zhiheng Wang, Prof Yalin Zheng, Dr Jianping Meng, Mr Zhuangzhi Gao

Scheduled presenter: Mr Zhiheng Wang · **Organisation:** University Of Liverpool · **Programme slot:** 14:12-14:14 · **Display:** Poster stand C · **Paper:** 233

DESCRIPTION OF PROPOSED TALK

Background

The retina reflects changes in eye health and systemic conditions such as diabetes, dementia, and heart disease. Current diagnostic methods use static images and limited clinical variables, which show structure but not function. Retinal digital twins-mathematical models simulating structure and blood flow-could provide dynamic predictions, but this area is understudied.

Methods

We use high-resolution, manually annotated images from the Fundus-AVSeg dataset to establish anatomical boundaries. We manually segmented a single retinal vessel from fundus images and applied interpolation to increase image resolution, enabling accurate geometry extraction for fluid simulation. We calculate the internal fluid dynamics using the Lattice Boltzmann Method (LBM) with a D2Q9 lattice model. To manage the memory requirements of larger domains, we parallelized the computation across multiple NVIDIA V100 GPUs on the Barkla High Performance Computing cluster. We integrated the cuDecomp library to automate the spatial domain decomposition and handle message passing interface (MPI) communications between the individual GPUs.

Results

Pressure-driven flow in a single vessel segment was successfully simulated, validating the LBM implementation against analytical solutions. GPU acceleration achieved significant speedups, and multi-GPU decomposition using cuDecomp is functional.

Conclusions

and Future Work: Three next steps are planned. First, extend the simulation from single vessels to multiple vessels and the whole retinal vascular network using measured geometries. Second, integrate LBM flow fields into physics-informed neural networks (PINNs) to build fast surrogate models. Third, use synthetic vascular data generated by a physics-informed deep generative model to augment training data, enabling robust performance with limited clinical data.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Development of Antibiofouling Surface Coatings for Managed Water Systems

Dr Mark Hunter, Prof Raechelle A D'Sa, Dr Jenny Aveyard, Mr Gary Hogben, Dr Yolla McCoy

Scheduled presenter: Dr Mark Hunter · **Organisation:** University Of Liverpool · **Programme slot:** 14:00-14:02 · **Display:** Poster stand C · **Paper:** 198

DESCRIPTION OF PROPOSED TALK

Bacterial colonisation of large-scale water distribution systems, as found in hospitals, is associated with the spread of disease (1). Once bacteria colonise these systems, they can form biofilms which can be difficult to eradicate through commonly used disinfection protocols, such as chlorination (1). Pathogenic and opportunistic bacteria that reside in these biofilms can be deleterious to human health. Therefore, prevention of microbial colonisation and subsequent biofilm formation is vital.

In this study, we explore the incorporation of copper-doped mesoporous silica nanoparticles into ethyl silicate-derived surface coatings as a potential route towards antibiofouling materials for managed water systems.

Copper-doped mesoporous silica nanoparticles were prepared using a modified Stöber method across a range of copper doping levels. Particles were characterised using transmission electron microscopy (TEM), scanning electron microscopy (SEM), dynamic light scattering (DLS), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX), and nitrogen adsorption / desorption analysis, including Brunauer-Emmett-Teller (BET) surface-area analysis.

Produced nanoparticles were incorporated into ethyl silicate-derived coating formulations synthesised for deposition onto water-system-relevant substrates. Coatings were applied using dip-coating, with formulation and application parameters varied to assess their respective influence on film formation and overall coating integrity. Coated substrates were analysed using SEM to evaluate surface morphology, coverage, and visible cracking. Preliminary observations indicate that coating integrity is sensitive to formulation and application conditions, with surface coatings produced at slower dip-coating rates showing reduced cracking and greater integrity than others under the deposition conditions studied.

Coating stability under aqueous exposure was also assessed, and the ability of each surface to inhibit biofilm formation was evaluated against *Pseudomonas aeruginosa* (*P. aeruginosa*) in nutrient-rich and nutrient-poor conditions.

In conclusion, copper-doped mesoporous silica nanoparticles were successfully produced and incorporated into ethyl silicate-derived coatings for potential application in managed water distribution systems. Coating integrity was assessed both as produced and following aqueous immersion, and the resulting surfaces were further evaluated for their antibacterial and antibiofilm activity against *Pseudomonas aeruginosa*.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Flexural Strength of 3D printed is Comparable to Milled materials for Cuspal Coverage Restorations: An In Vitro Study

Miss Sanapar Phadungcharoen, Rosti Readioff, Emad Moawad, Nicholas Longridge, Fadi Jarad

Scheduled presenter: Miss Sanapar Phadungcharoen · **Organisation:** University Of Liverpool · **Programme slot:** 14:02-14:04 · **Display:** Poster stand C · **Paper:** 6

DESCRIPTION OF PROPOSED TALK

Indirect cuspal coverage restorations play a vital role in the long-term survival of endodontically treated teeth. These restorations help protect the remaining tooth structure, restore function and provide aesthetics (1). Endodontically treated teeth are more prone to fracture due to its structural loss and reduced stiffness (2). Therefore, selection of restorative material is critical in minimising fracture risk and ensuring long term clinical success.

Computer-Aided Design/ Manufacturing (CAD/CAM) materials such as lithium disilicate and polymer infiltrated ceramic network (PICN) have demonstrated reliable outcome. Lithium disilicate is known for its high strength and fracture resistance while PICN material offer a combination of ceramic strength and polymer resilience which may improve distribution under functional loading(3, 4).

Recently, 3D-printed restorative materials have been introduced as more efficient and cost-effective solutions. These techniques allow higher precision manufacturing, shorter production time, cost savings, improved workflow and waste reduction (5). However, their mechanical performance remains uncertain due to differences in structure and fabrication process when compared with milled counterparts. Despite the increasing trends of these 3D printed materials there are still a lack of direct comparative research evaluating flexural strength of these materials. Therefore, this study aims to understand the suitability of 3D printed materials for endodontically treated teeth.

Bar-shaped specimens (n=12 per group; 4 x 1 mm; support span 12mm) were fabricated and specimens were tested using a three-point bending test. Mean flexural strength values were 136.69±12.57, 127.12±10.29, 142.04±16.31 and 367.09±58.03 MPa for Formlabs Permanent Crown, BEGO Varseosmile TriniQ, VITA Enamic, and IPS e.max CAD, respectively. IPS e.max CAD showed substantially higher flexural strength than all other materials. The PICN and both 3D printed resins showed similar values.

Lithium disilicate demonstrated superior flexural strength. 3D printed resins showed comparable values to PICN and may be suitable for single unit restoration. Future studies are required to assess long term behaviour, including fatigue resistance and colour stability.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Electrospun aligned PLA/silk fibroin nanocomposite scaffolds for tendon tissue engineering

Dr Fahad Alhamoudi, Dr Hafsah Akhtar

Scheduled presenter: Dr Fahad Alhamoudi · **Organisation:** King Khalid University · **Programme slot:** 14:04-14:06 · **Display:** Poster stand C · **Paper:** 8

DESCRIPTION OF PROPOSED TALK

Introduction

Tendon injuries are painful, slow to heal, and frequently associated with incomplete functional recovery. Conventional surgical repair often results in scar formation, inferior tissue organisation, and an increased risk of re-injury. Tissue engineering offers a promising alternative through biomimetic scaffolds that reproduce key structural and functional features of native tendons. In this study, electrospun poly(lactic acid) (PLA)-based composite nanofibrous scaffolds incorporating cerium oxide-based doped nanoparticles and silk fibroin were developed in random and aligned fibre configurations to mimic the anisotropic architecture of tendon tissue.

Materials and Methods

Scaffolds were fabricated by electrospinning to control fibre morphology and orientation. Random and aligned nanofibrous constructs were produced and characterised using Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and X-ray diffraction (XRD). SEM was further used to assess fibre diameter, morphology, and alignment. Physicochemical properties relevant to scaffold performance were evaluated, including wettability, swelling, porosity, and density. In vitro degradation was assessed to examine scaffold stability over time. Antibacterial activity was also investigated. Mechanical behaviour under dry and wet conditions, including performance after degradation, was evaluated to determine the suitability of the scaffolds for tendon repair applications.

Results

The results confirmed successful fabrication of the composite scaffolds and incorporation of the intended components. FTIR identified the expected chemical groups, while SEM demonstrated a continuous nanofibrous morphology with distinct random and aligned architectures. The aligned scaffolds more closely reproduced the organised fibre arrangement of the native tendon. The scaffolds exhibited favourable wettability, porosity, density, and swelling behaviour, indicating a microenvironment supportive of tissue regeneration. In vitro degradation exhibited a stability profile consistent with tendon-healing requirements. Antibacterial activity was observed, suggesting an additional protective benefit against infection. Overall, the aligned and composite scaffold design showed structural and functional features desirable for tendon tissue engineering.

Conclusion

These electrospun PLA-based composite scaffolds demonstrated promising physicochemical and functional properties for tendon regeneration. In particular, fibre alignment improved the biomimetic design by better reproducing native tendon architecture. The developed scaffold system, therefore, represents a promising platform for soft tissue repair and tendon tissue engineering.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Gold nanoparticle synthesis using Manuka honey

Mrs Shanice Allen, Jenny Shepherd, David Adlam, Natalie Allcock

Scheduled presenter: Mrs Shanice Allen · **Organisation:** University of Leicester · **Programme slot:** 14:06-14:08 · **Display:** Poster stand C · **Paper:** 24

DESCRIPTION OF PROPOSED TALK

Introduction

Approximately 1 in 5 men and 1 in 7 women in the UK will die from coronary heart disease (CHD)¹. It is a chronic disease occurring when the coronary arteries become narrowed as a result of fatty deposits accumulating within their walls, known as atherosclerosis. There is no current cure for atherosclerosis, and existing treatments focus solely on management.

With the off-target toxicity of many promising drugs, there is a significant drive for localised drug delivery with gold nanoparticles (AuNPs) forming an attractive option. Some concerns exist around the toxicity of AuNPs^{2,3}, in part a consequence of the reagents utilised during the synthesis. Various green chemistry methods have been implemented, including honey-mediated AuNP synthesis. Honey cannot be purchased as a reagent-grade chemical, and as such, there is no measure of its consistency or how this might influence the synthesised nanoparticles and their potential application in cardiovascular drug delivery^{4,5}.

This work aims to demonstrate the production of honey-mediated AuNPs using various concentrations of Manuka honey, supporting methodologies previously reported⁶. This work presents comparative TEM to convey AuNPs size, morphology, and polydispersion. Liquid chromatography mass spectrometry (LC-MS) was considered to elucidate the characteristics of various types of honey.

Method

20g of Monofloral 240 MGO manuka honey (Manuka Doctor, UK) was diluted in 70ml of deionised water and stirred for 20 minutes. 50mg of HAuCl₄ was dissolved in 120ml of deionised water. Various volumes of the aqueous solution of honey (10ml and 30ml) were then combined with 30ml of the HAuCl₄ aqueous solution and stirred until colour changes to red-wine colour were observed. The shape, size and distribution of samples were then observed using a JEOL JEM-1400 TEM with an accelerating voltage of 120kV. Images were captured using an EMSIS Xarosa digital camera with Radius software.

Results

This methodology successfully synthesised AuNPs at room temperature, showing great potential as an effective, economical technique of synthesising AuNPs for biomedical applications. Moreover, these findings have shown that dispersion, quantity and shapes depend on the ratio of honey solution to the HAuCl₄ aqueous solution.

Conclusion

This research has outlined the capabilities of honey-mediated AuNP synthesis. Future research will include characterising these AuNPs further, as well as synthesising AuNPs with various types of honey. Differences in honey composition will also be analysed to elucidate the effects that various types of honey may have on AuNP synthesis.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Development of Inhaled Therapeutic Polymeric Nanoparticles for the Treatment of Respiratory Infections

Ms Imogen Walker, Prof Raechelle D'Sa, Dr Jenny Aveyard

Scheduled presenter: Ms Imogen Walker · **Organisation:** University Of Liverpool · **Programme slot:** 14:08-14:10 · **Display:** Poster stand C · **Paper:** 50

DESCRIPTION OF PROPOSED TALK

Introduction

Respiratory infections remain a leading global cause of death, with lower respiratory infections claiming 2.6 million lives in 2019.¹ The rise of multidrug resistance has rendered traditional antibiotics increasingly ineffective. Nitric oxide (NO) offers a promising alternative due to its broad-spectrum antimicrobial activity and multiple inhibitory mechanisms that minimize resistance.² However, delivering gaseous NO to infection sites is challenging. This project aims to develop degradable polymeric nanoparticles to deliver a known dose of NO via inhalation.³

Materials and Methods

Linear and hyperbranched polymers were synthesised in anhydrous solvents. These were modified and nitrosylated using an in-house donor to achieve high NO loading. Characterization was performed via NMR, FTIR, rheology and GPC. NO release kinetics were quantified in various media (LB, PBS, BAL supernatant, artificial mucus) using chemiluminescence. Antimicrobial efficacy against planktonic and biofilm cultures of *S. aureus*, *P. aeruginosa*, *H. influenzae*, *S. pneumoniae* was evaluated alongside NL20 cell cytocompatibility. Nanoparticles were formed using various methods the most successful being electrospraying.

Results and Discussion

All polymers exhibited high payloads, releasing over 200 $\mu\text{M mg}^{-2}$ over 24 hours. They achieved complete planktonic and biofilm eradication of Gram-positive and Gram-negative bacteria in nutrient-rich and BAL environments. While efficacy was maintained in nutrient-poor conditions, no significant kill was observed in artificial mucus. At bactericidal concentrations no cytotoxicity was observed. In summary, these polymers provide controlled NO delivery and potent antimicrobial action. Future research will focus on formulation optimization and aerosolization for clinical application.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Development of Delivery Platforms for RNA-Based Immunotherapy in Lung Cancer

Miss ZIYUE Su, Dr Vahid Heravi Shargh, Dr Jenny Hanson, Dr Kai-Ti Lin, Prof Raechelle D'Sa

Scheduled presenter: Miss ZIYUE Su · **Organisation:** University Of Liverpool · **Programme slot:** 14:10-14:12 · **Display:** Poster stand D · **Paper:** 67

DESCRIPTION OF PROPOSED TALK

Lung cancer is one of the most prevalent cancers worldwide and remains the major cause of cancer-related mortality. While conventional treatments often result in significant side effects and recurrence, RNA-based therapies, including mRNA and RNA interference (RNAi), offer a promising therapeutic approach to regulate gene expression linked to cancer initiation and progression. However, clinical translation of RNA-based therapies faces challenges due to the instability of naked RNA in vivo. Therefore, low toxicity, biodegradable, and high transfection efficiency delivery systems are required for effective intracellular transportation. In this study, we aim to develop lipid nanoparticles (LNP) to enhance RNA delivery into lung cancer cells and tissues in vitro and in vivo.

The RNA-LNPs were formulated by optimizing the synthesis parameters and the molar ratios of ionisable aminolipids and cholesterol. The resulting RNA-LNP complexes exhibited an average particle size of ~ 100 nm with a narrow size distribution and a near neutral surface charge (+2.77 mV). RiboGreen assay confirmed RNA loading with an encapsulation efficiency above 90%. Furthermore, cellular uptake studies via confocal microscopy demonstrated significant internalisation within 1 hour, confirming successful uptake and delivery, indicating the potential as RNA delivery carriers.

In this study, we successfully formulated and optimised the mRNA-LNPs and miRNA-LNPs with promising physicochemical properties and effective encapsulation for nuclei acid delivery. These characteristics highlight their potential as a versatile platform for RNA-based lung cancer therapy. Future work will focus on the in vitro endosomal escape performance and therapeutic efficacy in in vivo lung cancer models.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Optimisation of Degumming and Dissolution Parameters in Silk Fibroin for Biosensing Applications

Mr Sam Scott, Professor Frederik Claeyssens, Dr David Gregory

Scheduled presenter: Mr Sam Scott · **Organisation:** University Of Sheffield · **Programme slot:** 14:12-14:14 · **Display:** Poster stand D · **Paper:** 95

DESCRIPTION OF PROPOSED TALK

Silk fibroin has attracted increasing interest as a material for biosensor applications due to its biocompatibility, tunable properties, and flexibility in device fabrication. However, inconsistencies in processing, particularly during degumming and dissolution, can lead to significant variation in material properties, which in turn affects reproducibility and overall performance (Rockwood et al., 2011¹). For biosensor use, it is important that silk fibroin exhibits controlled molecular weight, structural stability, and good processability, all of which are strongly influenced by the initial processing steps.

Here, we explore silk fibroin processing with a focus on degumming and dissolution to produce consistent and usable regenerated silk fibroin (RSF). Degumming was carried out using weak alkaline conditions (NaHCO₃ solutions), with concentration and temperature varied to examine their effect on sericin removal, degradation of fibroin, and to retain the native molecular weight of the silk fibroin. Structural changes were characterised using FTIR, with spectral deconvolution used to assess β -sheet and unordered regions. Additionally, an emerging method of picric acid carmine staining (PACs) has been implemented to further highlight the degree of sericin removal. Enzymatic degumming using papain was also investigated as an alternative approach, showing effective sericin removal while maintaining fibroin integrity (Gulrajani et al., 2000²).

Dissolution was studied through a comparison of lithium bromide (LiBr) and Ajisawa's reagent (CaCl₂-ethanol-water), with attention given to dissolution efficiency, structural preservation, and the resulting solution properties. These were characterised using a combination of gel electrophoresis, UV-Vis spectroscopy and viscometry. Additionally, tensiometry was employed to evaluate the variations in Z-number of the silk inks (Liu and Derby, 2016³), which is an indicator of ink printability for reactive inkjet printing, a fabrication method of silk-based sensing devices (Gregory et al., 2016⁴). The RSF was further processed into microneedle structures to demonstrate its ability to form complex geometries (Tsioris et al., 2012⁵), with morphology and structural integrity assessed using scanning electron microscopy (SEM).

Finally, photocurable silk fibroin was also developed using riboflavin-based crosslinking and methacrylation approaches, enabling light-induced curing and improved control over material structuring (Brif et al., 2019⁶), which is vital for stereolithography used for creating the desired biosensor. Overall, this work highlights how processing conditions directly influence silk fibroin properties and provides a basis for developing more reliable and scalable fabrication methods for silk-based biosensors.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Deciphering the Role of Degumming and Dissolution in Regenerated Silk Fibroin for Reactive Inkjet Printing.

Mr Faruk Mustapha Abdullahi, Ms. Leo Fish, Dr. David Alexander Gregory, Dr. Enrico Ferrari

Scheduled presenter: Mr Faruk Mustapha Abdullahi · **Organisation:** University Of Sheffield · **Programme slot:** 14:14-14:16 · **Display:** Poster stand D · **Paper:** 107

DESCRIPTION OF PROPOSED TALK

Silk has emerged as a promising biomaterial for biomedical applications including tissue engineering and biosensing, owing to its tunable properties. However, a wide range of processing methodologies exists, and few systematic studies have investigated how processing parameters influence silk degradation, molecular integrity, and material performance.

Here, we systematically investigate the influence of Ajisawa dissolution conditions on silk degradation, molecular integrity, and material performance. With recent advances in reactive inkjet (RIJ) printing of silk, understanding silk properties required for applications such as 3D structures, scaffolds, and sensing devices is increasingly important.¹

In particular, processing parameters must be refined to produce regenerated silk fibroin (RSF) inks with rheological properties suitable for stable jetting and pattern formation.²

Using a design of experiments (DoE) approach based on a fractional factorial design with centre points and replicates, we investigated the effects of degumming time and temperature in 0.02 M Na₂CO₃ on sericin removal efficiency and silk degradation. Furthermore, we evaluated how dissolution parameters (time and temperature) in Ajisawa's solution (CaCl₂:H₂O:EtOH, 1:2:8 molar ratio) influence the molecular weight and structural stability of regenerated silk fibroin solutions.

Fibres and regenerated films were characterised using scanning electron microscopy (SEM) and Fourier transform infrared spectroscopy (FTIR). SEM micrographs revealed morphological changes consistent with sericin removal across low, intermediate, and high degumming conditions, together with fibrillar morphology. FTIR spectra indicated condition-dependent variations within the amide I region, reflecting changes in secondary structure.⁴

Gel electrophoresis revealed partial smearing between 268 and 71 kDa, together with a faint ~25 kDa light-chain band, indicating partial fibroin degradation while retaining high molecular weight species. Fractions were estimated at 250-390 kDa, while lower molecular weight fractions were observed between 30-35 kDa.⁷

The Z-number of the RSF solutions was calculated to evaluate printability for RIJ printing.⁶ In parallel, biocompatibility and surface interaction properties were assessed through cell adhesion assays and contact angle measurements to determine hydrophobicity.⁵ These parameters are critical in defining jetting stability, substrate wetting, and overall printing performance.³

Tuning of RSF processing parameters provides insight into the conditions required to produce formulations suitable for RIJ, while preserving molecular weight integrity and the inherent mechanical properties of fibroin. Furthermore, this study highlights the processing parameters with the greatest influence on silk molecular weight, degradation behaviour, and β -sheet formation, which are critical for applications extending beyond RIJ, including tissue engineering and biosensing.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Mapping printability in a crosslinking bioink-support bath system for SLAM bioprinting

Mr Charlie Milnes, Dr Laurence Hill, Professor Iain Whittaker, Dr Dan Curtis, Professor Hari Arora

Scheduled presenter: Mr Charlie Milnes · **Organisation:** Swansea University · **Programme slot:** 14:16-14:18 · **Display:** Poster stand D · **Paper:** 236

DESCRIPTION OF PROPOSED TALK

Suspended Layer Additive Manufacturing (SLAM) enables fabrication of soft hydrogel constructs by extruding bioinks into a yield-stress support bath that stabilises deposited filaments. However, optimisation remains largely empirical because print outcomes depend on coupled interactions between bioink composition, support bath properties, rheology, crosslinking chemistry and printing parameters. This trial-and-error approach increases development time, material use and cost, while limiting structured datasets needed for predictive printability modelling.

This study proposes a systematic printability-mapping workflow for a crosslinking bioink-support bath system. The approach builds on competitive ligand exchange for ion-mediated hydrogel formation described by Bassett et al. (2016), the agarose fluid-gel support bath framework used in SLAM by Senior et al. (2019), and printability-mapping methods that link rheological and processing conditions to filament morphology and diameter, as demonstrated by Jin et al. (2017). An alginate, hyaluronic acid and nanocellulose hydrogel bioink will be investigated alongside an agarose-based SLAM support bath. Bioink and bath compositions will be varied in a structured manner to alter relative rheological behaviour and the crosslinking environment, rather than screening formulation space arbitrarily. This ion-mediated strategy is intended to regulate gelation onset, supporting stable filament formation and improved shape fidelity during printing.

For each bioink-bath condition, rheological behaviour will be characterised using viscosity, yield stress, storage modulus, loss modulus, viscoelastic ratio and recovery behaviour. Printing trials will vary nozzle diameter, extrusion pressure and printhead path speed, while flow-derived parameters, including volumetric flow rate and nozzle outlet velocity, will be measured to relate controllable inputs to filament morphology and stability. Informed by work highlighting interactions between material properties, bath behaviour, printing conditions, crosslinking and post-printing treatment in embedded bioprinting (Wu et al., 2024), these measurements will enable comparison across formulation-process conditions. This will allow distinct printing regimes to be mapped, guide convergence towards application-relevant bioink-bath systems, and identify material and process parameters most influential to printability. These descriptors will inform feature selection for future machine-learning models, including rheology-informed suspended bioprinting prediction approaches (Oh et al., 2025). Printability will be assessed using filament diameter, diameter variability, morphology classification, continuity, surface quality and time-dependent filament stability.

This workflow will generate a system-specific printability map linking formulation, rheology, deposition conditions and filament outcomes. The study aims to identify stable, repeatable and biologically relevant printing windows, providing a structured foundation for predictive modelling of SLAM bioprinting performance and reducing reliance on empirical, material-intensive optimisation in embedded bioprinting workflows.

P03**Biomaterials****Thursday 3 September 2026** · 14:00-14:20 · Space Five**Chairs:** Professor Martin Knight · Dr Jenny Hanson

Gelatine-based foams produced by enzymatic foaming: formulation-structure relationships affecting expansion and stability

Dr Shwan Abdullah Hamad

Scheduled presenter: Dr Shwan Abdullah Hamad · **Organisation:** Komar University Of Science And Technology · **Programme slot:** 14:18-14:20 · **Display:** Poster stand D · **Paper:** LB04

DESCRIPTION OF PROPOSED TALK

Advanced wound care requires dressing materials that are highly conformable, biocompatible, and capable of managing physiological exudate efficiently. Biodegradable biopolymer foams represent a promising solution; however, achieving controlled structural expansion while maintaining mechanical stability under physiological conditions remains a translational challenge. This study investigates an innovative method for producing gelatine-based foams via enzymatic expansion, systematically evaluating how formulation parameters dictate structural and physical properties.

Gelatine solutions were dynamically foamed using an enzymatic reaction, balancing gas evolution kinetics with the progressive cross-linking of the biopolymer network. The relationships between initial formulation components, foam expansion kinetics, and long-term structural stability were characterized.

The results demonstrate a distinct trade-off between peak foam expansion and structural stability. Higher enzymatic activity yielded rapid initial expansion but accelerated early structural collapse if cross-linking density was insufficient. Conversely, optimizing the formulation matrix enabled the fabrication of highly porous, stable gelatine architectures with sustained integrity under physiological challenges. The findings provide essential formulation-structure design rules for engineering stable, enzymatically expanded biopolymer scaffolds, offering significant potential for advanced wound care and soft tissue engineering applications.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Investigating circadian clock dysregulation in acute aortic dissection and thoracic aortic aneurysm

Mrs Martina Marinova

Scheduled presenter: Mrs Martina Marinova · **Organisation:** University Of Liverpool · **Programme slot:** 14:00-14:02 · **Display:** Poster stand D · **Paper:** 181

DESCRIPTION OF PROPOSED TALK

Thoracic aortic aneurysm (TAA) and acute aortic dissection (AAD) are closely related, life-threatening conditions of the aorta characterised by abnormal dilation of the vessel wall and a tear in the intimal layer, respectively. The circadian clock is an endogenous 24-hour timekeeping system driven by rhythmic oscillations in circadian clock gene expression. The circadian clock plays a role in maintaining vascular health, and dysregulation of clock gene expression has been shown to impair vascular structure and function. However, it remains unclear whether the molecular circadian clock is disrupted in TAA and AAD and whether such disruption contributes to the pathogenesis of these conditions.

To investigate local and systemic circadian clock dysregulation, the expression of core circadian clock proteins (BMAL1, CRY1, and REV-ERB α) was quantified and compared in aortic tissue and serum samples from AAD, TAA, and control individuals using immunohistochemistry (n = 5 per group) and dot blots (n = 8 per group). To assess whether systemic factors contribute to circadian disruption, the effects of AAD, TAA, and control serum on core circadian clock gene and protein expression were examined in a cell model using RT-qPCR and Western blot analyses (n = 3 per group). Furthermore, all circadian clock data were correlated with biomechanical and atomic force microscopy (AFM) imaging data probing the extracellular matrix (ECM) distribution in TAA and AAD tissue samples.

Preliminary immunohistochemistry data demonstrated that, across all clock proteins, expression in TAA was more heterogeneous and showed a trend toward higher levels compared to AAD and controls, while AAD expression patterns were similar to controls.

These pilot findings suggest a potential local alteration in circadian clock protein expression in the aortae of TAA patients, with further analyses underway to strengthen these observations and investigate systemic circadian disruption, the contribution of circulating factors, and the association between circadian dysregulation and ECM degradation, which may help identify novel biomarkers and therapeutic targets to improve outcomes for TAA and AAD patients.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Intracardiac Soft Robotic Design for CPR Application

Mr Zhihao Ma, Mr Linxiaohai Ning, Ms Xinxin Li, Professor Tim Harris, Professor Zion Tse

Scheduled presenter: Mr Zhihao Ma · **Organisation:** Queen Mary University Of London · **Programme slot:** 14:02-14:04 ·**Display:** Poster stand D · **Paper:** 154

DESCRIPTION OF PROPOSED TALK

Cardiac arrest remains a major global health challenge. Traditional closed-chest cardiopulmonary resuscitation has limited haemodynamic efficiency because only a small fraction of normal cardiac output can be achieved. Open-chest cardiac massage can provide more effective circulation, but its highly invasive nature and infection risk restrict its usage. There is a need for a minimally invasive approach that can provide direct cardiac compression while reducing tissue damage.

This work demonstrates a soft robotic design for minimally invasive direct heart massage. The system integrates two soft eversion robots with two soft inflatable catheters. The eversion robots act as deployment and guidance structures, enabling the system to operate within a limited thoracic and lung region to cover the heart. It can also reduce sliding friction and tissue disturbance. Once deployed, the eversion structures create a temporary soft pathway, and the catheter can be guided towards the target cardiac region. The catheter balloons then act as compression actuators, applying mechanical pressure to the heart surface through inflation and deflation.

The laboratory evaluation using a human chest model and a soft silicone heart phantom. The experiment assessed the deployment capability of the outer eversion robots, the advancement of the inner catheter modules, and the compression effect produced by balloon inflation. Current observations showed that an input pressure of approximately 4 psi was sufficient to deploy the outer eversion balloons through the thoracic gap and guide them towards the target region. The inner catheter balloons could be advanced into the outer balloons and inflated once the balloons reached the phantom. A syringe was used to actuate a single catheter balloon and produce quantifiable localised ventricular deformation of the silicone heart phantom. Measurements showed that a single balloon compression generated an output force of approximately 2-3 N. In addition, electromagnetic tracking of a marker attached to the phantom indicated the soft robotics system achieved a peak displacement of 16.3 mm relative to the pre-test baseline, including the deployment-induced compression from the outer balloons. During inner-balloon actuation, an approximately 10 mm cyclic stroke was maintained over 60 s, demonstrating robustness under continuous compression.

Future work will focus on developing a customised biocompatible inner balloon, optimising actuator geometry, and improving cyclic compression performance. A closed-loop control strategy will also be implemented to regulate actuation pressure, compression frequency, and deformation response. The future system will incorporate pressure sensing and flexible electrode pads for detecting ECG signals on the heart surface.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Cuff and Intra-arterial blood pressure bias differs by pressure component: A meta-regression analysis

Miss Chuying Liang

Scheduled presenter: Miss Chuying Liang · **Organisation:** University Of Manchester · **Programme slot:** 14:04-14:06 ·**Display:** Poster stand E · **Paper:** 237

DESCRIPTION OF PROPOSED TALK

Small inaccuracies in blood pressure measurement can have consequences that extend far beyond an individual reading. At the population level, modelling evidence from Canada suggests that a positive bias of only 5 mmHg in systolic or diastolic pressure could move around 1.3 million adults from the normotensive to hypertensive category. Despite this clinical importance, cuff-based non-invasive blood pressure remains an indirect estimate of arterial pressure and a persistent discrepancy from invasive intra-arterial pressure is still observed. Whether this discrepancy differs systematically across systolic blood pressure, diastolic blood pressure, and mean arterial pressure remains insufficiently characterised.

Previous meta-analyses have shown that cuff BP systematically differs from intra-arterial BP, typically underestimating SBP and overestimating DBP. Picone et al. and Dankel et al. reported this component-specific pattern, while Dankel et al. further found that SBP bias was moderated by arterial site and cuff-size selection. More recently, Becker et al. showed clinically relevant SBP underestimation in critical care, with exploratory associations involving mechanical ventilation, age and sex. However, device-, cuff-, patient-, setting- and reference-related determinants have not yet been evaluated together within one upper-arm cuff-based framework across SBP, DBP and MAP.

This study conducted a meta-analysis of adult studies comparing upper-arm cuff-based non-invasive blood pressure measurements with invasive intra-arterial reference values. Bias was defined consistently as non-invasive minus intra-arterial blood pressure. Random-effects models were used to estimate pooled bias for SBP, DBP, and MAP, while subgroup analyses and univariable and multivariable meta-regression were used to explore sources of heterogeneity across measurement method, device type, manufacturer, cuff suitability, BMI, age, arterial reference site, and clinical setting.

Across 58 studies involving 5,519 participants, preliminary findings showed a component-specific pattern: cuff-based measurement underestimated SBP, overestimated DBP, and underestimated MAP. The expected contribution of this work is to shift interpretation of cuff-based blood pressure error away from a single correction coefficient toward a component-specific and context-sensitive framework. These findings suggest that cuff-intra-arterial bias may reflect a possible interaction between cuff mechanics, soft-tissue pressure transmission, haemodynamic state, and device signal processing, rather than a single uniform measurement error.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Extracellular Matrix Microarchitecture and Biomechanical Implications in Bicuspid and Tricuspid Aortic Valve-Associated Thoracic Aortic Aneurysms

Mr Daniel Riley, Dr Riaz Akhtar

Scheduled presenter: Mr Daniel Riley · **Organisation:** University Of Liverpool · **Programme slot:** 14:06-14:08 · **Display:** Poster stand E · **Paper:** 206

DESCRIPTION OF PROPOSED TALK

Thoracic aortic aneurysm (TAA) is a life-threatening vascular condition that often progresses silently until dissection or rupture, events associated with mortality rates exceeding 90 %. (Gouveia e Melo et al., 2022) Patients with bicuspid aortic valve (BAV) have a markedly higher lifetime risk of developing TAA than those with tricuspid aortic valve (TAV), yet the underlying tissue mechanisms remain poorly defined. This study aimed to investigate extracellular matrix (ECM) composition and organisation in aneurysmal tissue from BAV-associated aneurysms (BAV-A) and TAV-associated aneurysms (TAV-A) to better understand their pathophysiology and clinical implications.

Aortic tissue samples from 53 patients (27 BAV-A, 26 TAV-A) were histologically stained to evaluate glycosaminoglycan, elastin, and collagen content, and digitised for quantitative and semi-quantitative analysis. Additional analyses assessed the architecture of the elastic lamellae and graded medial degeneration severity.

Results

from these tests demonstrated that BAV-A samples exhibited elevated medial fractions of elastin and collagen, along with higher elastin content across the full thickness of the aortic wall (tunica intima, media, and adventitia). Semi-quantitative assessment further revealed that BAV-A samples displayed a more preserved medial architecture compared with TAV-A samples. Correlation analyses showed strong associations between decreasing medial elastin fraction and increasing aortic diameter in TAV-A patients, whereas no such relationship was observed in BAV-A patients. Similarly, while TAV-A samples demonstrated a strong negative correlation between medial elastin fraction and medial degeneration score, this association was weak in BAV-A samples.

These findings support the hypothesis that BAV-A may represent a more benign or adaptive phenotype compared to the degenerative nature of TAV-A. Clinically, this suggests that risk stratification based solely on aortic diameter may overestimate the surgical urgency in BAV-A patients, highlighting the potential need for phenotype-specific management strategies.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Predicting Hemolysis Index: Unsteady Reynolds-averaged Navier-Stokes vs Large Eddy Simulation

Ms Peiyang Sun, Prof Esra Sorguven

Scheduled presenter: Ms Peiyang Sun · **Organisation:** University of Sussex · **Programme slot:** 14:08-14:10 · **Display:** Poster stand E · **Paper:** LB06

DESCRIPTION OF PROPOSED TALK

Precise numerical prediction of blood damage is essential to prevent hemolytic or thrombotic complications in patients, as well as to decrease the number of in-vitro tests during biomedical device design and development. Yet, existing studies do not fully explain how hemolysis due to instantaneous local shear stresses can be modelled in turbulent flows. It is particularly challenging for blood vessels, which experience laminar, transitional and turbulent flows throughout one cardiac period. The purpose of this study is to assess the effect of turbulence modelling on the hemolysis index prediction in a patient-specific aorta model under constant-speed left ventricular assist device (LVAD) support. The Reynolds number of this flow varies between 0 and 3000 during one cardiac period.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

One-step diffusion-based virtual staining for label-free ultraviolet photoacoustic histology

Mr Feng He, Ms Charissa Cheong, Mr Ziyu Ye, Ms Samia Zaman, Ms Cheuk Tung Lau, Professor Christos Bergeles, Professor Sebastien Ourselin, Professor Sebastien Ourselin, Professor Keyoumars Ashkan, Dr Wenfeng Xia

Scheduled presenter: Mr Feng He · **Organisation:** King's College London · **Programme slot:** 14:10-14:12 · **Display:** Poster stand E · **Paper:** 126

DESCRIPTION OF PROPOSED TALK

Ultraviolet photoacoustic microscopy with virtual staining provides haematoxylin and eosin (H&E)-like images of tissue based on the intrinsic optical absorption of DNA/RNA, without reliance on chemical staining or frozen-section preparation. In breast and prostate pathology, rapid H&E-like visualisation of unstained tissue could support time-critical workflows such as intraoperative margin assessment, specimen triage and digital pathology review. Such images must preserve not only nuclear morphology but also eosin-like cytoplasmic colour, stromal texture and tissue architecture, which provide essential context for assessing nuclear-to-cytoplasmic relationships, ductal and glandular organisation, tumour-associated stromal change and grading-related architectural patterns.

Existing ultraviolet photoacoustic virtual histology studies have mainly used cycle-consistent generative adversarial networks (CycleGANs) to translate label-free ultraviolet microscopy images into brightfield-style histology. These methods can reproduce nuclei-rich regions, but conventional unpaired generative adversarial network (GAN)-based translation may over-smooth cytoplasmic regions, weaken stromal texture or reduce eosin-like colour fidelity. These limitations are particularly important in breast and prostate tissues, where non-nuclear morphology provides important contextual information for pathological interpretation.

We developed a one-step diffusion-based virtual staining pipeline for label-free ultraviolet photoacoustic histology in breast and prostate tissues. The input combines two inherently co-registered ultraviolet modalities enabling complementary contrasts acquired from the same tissue regions: ultraviolet photoacoustic remote sensing (UV-PARS) microscopy, which highlights nuclear features through ultraviolet absorption, and ultraviolet scattering microscopy, which provides cytoplasmic and stromal information. The proposed pipeline adapts a pre-trained single-step diffusion image translation framework, based on CycleGAN-Turbo, to generate H&E-like virtual histology from these dual-contrast ultraviolet inputs. In contrast to conventional CycleGAN, contrastive unpaired translation (CUT) and FastCUT approaches, this method uses a pre-trained diffusion image prior together with image-conditioned translation and skip-connected reconstruction to retain tissue structure while improving fine-texture representation.

The study assesses structural similarity index measure, peak signal-to-noise ratio, Pearson correlation coefficient and region-level visual agreement with corresponding brightfield H&E references. The analysis focuses on preservation of nuclear morphology, cytoplasmic colour fidelity, stromal texture continuity and tissue architecture in breast and prostate regions. This work investigates whether one-step diffusion image translation can improve the pathological interpretability of label-free ultraviolet photoacoustic virtual staining by preserving both nuclear and non-nuclear histological features.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Reflection-mode multimode fibre image transmission with physics-guided attention reconstruction towards ultrathin endoscopy

Mr Ziyu Ye, Mr Feng He, Dr Tianrui Zhao, Dr Wenfeng Xia

Scheduled presenter: Mr Ziyu Ye · **Organisation:** King's College London · **Programme slot:** 14:12-14:14 · **Display:** Poster stand E · **Paper:** 135

DESCRIPTION OF PROPOSED TALK

Ultrathin endoscopy is highly attractive for real-time tissue assessment in narrow or difficult-to-reach anatomical regions of the body. Multimode fibres (MMFs) are promising candidates for such probes owing to their low-cost, flexibility, and ability to support many transverse optical modes for high-resolution imaging. Most previous MMF imaging studies have focused on transmission-mode configuration, where object information is collected after light propagation through the fibre. For biomedical endoscopy, however, the distal end of the fibre is usually inaccessible, making reflection-mode imaging more practical and clinically relevant. In reflection-mode MMF imaging, object information is returned through the same fibre as a scrambled speckle pattern. Recovering a wide-field image from this pattern is challenging because of double-pass modal mixing, weak back-scattered signals, and imperfect reflection coupling. Here, we propose a single-shot reflection-mode MMF imaging framework that combines a reflected real-valued intensity transmission matrix (reflected-RVITM) with a hierarchical parallel multi-scale attention U-Net (HPM-Attention-UNet). The system uses one MMF for both light delivery and signal collection. Reflected light is coupled back into the same fibre and recorded at the proximal end as a speckle intensity pattern. The reflected-RVITM links distal object information to the measured reflected speckle using intensity-only calibration, avoiding interferometric phase retrieval and enabling compact reflection-mode hardware. It provides a physics-guided first reconstruction, reducing the need for the neural network to learn the full optical inverse problem from raw speckle alone. HPM-Attention-UNet is then used as a restoration network to remove artifacts from calibration mismatch. Attention blocks suppress speckle-like background distortion, while the multi-scale U-Net design preserves structures and fine details. This hybrid strategy aims to support single-shot, wide-field image recovery in reflection without distal scanning or access to the far end of the fibre during imaging. Reconstruction quality is assessed using structural similarity index measure, peak signal-to-noise ratio, Pearson correlation coefficient, and visual assessment, with comparisons against reflected-RVITM-only reconstruction and direct learning-based recovery. Experiments include both digital micromirror device (DMD)-generated targets and real objects to test controlled reconstruction accuracy and practical imaging performance. Overall, this approach offers a practical route toward compact MMF-based reflectance imaging for minimally invasive biomedical inspection, microneedle guidance, and in situ tissue imaging.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Dense normalization enables seamless virtual staining in label-free ultraviolet photoacoustic histology

Mr Feng He, Ms Samia Zaman, Mr Ziyu Ye, Ms Charissa Cheong, Ms Cheuk Tung Lau, Professor Christos Bergeles, Professor Sebastien Ourselin, Professor Keyoumars Ashkan, Dr Wenfeng Xia

Scheduled presenter: Mr Feng He · **Organisation:** King's College London · **Programme slot:** 14:14-14:16 · **Display:** Poster stand E · **Paper:** 127

DESCRIPTION OF PROPOSED TALK

Label-free ultraviolet photoacoustic histology with virtual staining can generate haematoxylin and eosin (H&E)-like images from unstained tissue, supporting faster digital histology workflows without conventional chemical staining. For breast and prostate specimens, however, virtual staining must remain reliable over large tissue regions rather than isolated image patches. Patch-wise processing of high-resolution images can introduce visible seams, local colour shifts and inconsistent cytoplasmic or stromal contrast between neighbouring regions. These artefacts may interrupt glandular, ductal or stromal continuity and reduce the interpretability of large-area virtual H&E-like images used for pathology review.

Existing ultraviolet photoacoustic virtual histology studies have mainly focused on improving the image translation model itself, commonly using cycle-consistent generative adversarial networks (CycleGANs) to generate brightfield-style histology from label-free ultraviolet images. However, even when individual patches are translated well, large-area inference remains vulnerable to patch-boundary artefacts because standard normalisation is applied independently within each patch. This is a practical limitation for digital pathology applications, where pathologists interpret continuous tissue architecture across fields of view rather than isolated small crops.

We developed a dense normalization-enhanced virtual staining pipeline for label-free ultraviolet photoacoustic histology in breast and prostate tissues. The input combines two inherently co-registered ultraviolet modalities enabling complementary contrasts acquired from the same tissue regions: ultraviolet photoacoustic remote sensing (UV-PARS) microscopy, which highlights nuclear features through ultraviolet absorption, and ultraviolet scattering microscopy, which provides cytoplasmic and stromal information. A contrastive unpaired translation (CUT/FastCUT) backbone is used to generate H&E-like virtual histology from these dual-contrast ultraviolet inputs. During large-area inference, standard patch-level normalisation is replaced by dense normalization, which estimates spatially varying pixel-level statistics from neighbouring patches. This allows local colour and contrast statistics to vary smoothly across patch boundaries while preserving tissue texture within each region.

The study assesses structural similarity index measure, peak signal-to-noise ratio, Pearson correlation coefficient and region-level visual agreement with corresponding brightfield H&E references. The analysis focuses on boundary continuity, colour consistency, cytoplasmic and stromal contrast stability, and preservation of large-area tissue architecture. This work investigates whether dense normalization can improve the practical usability of label-free ultraviolet photoacoustic virtual staining by making high-resolution virtual histology more seamless, spatially coherent and suitable for large-area pathology interpretation.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Towards articulated optical ultrasound imaging for minimally invasive surgery

Ms Nyma Nassren, Dr Robert Stafford-Williams, Dr Shaoyan Zhang, Dr Semyon Bodian, Dr Eleanor Mackle, Dr Edward Zhang, Prof Paul Beard, Prof Hani Marcus, Dr Erwin Alles

Scheduled presenter: Ms Nyma Nassren · **Organisation:** UCL · **Programme slot:** 14:16-14:18 · **Display:** Poster stand E · **Paper:** 183

DESCRIPTION OF PROPOSED TALK

Minimally invasive surgery is currently one of the safest and most effective treatment options for tumours that develop near critical structures, such as pituitary tumours that occur near the brain and optic nerves. These tumours are common, with an overall occurrence rate of 17% [1], and if left untreated, can lead to severe loss of vision and unsustainable hormone imbalances. Transsphenoidal surgery is one form of minimally invasive surgery whereby rigid instruments are inserted through the nose to access the pituitary gland and remove the tumour, under endoscopic guidance. Typically, with endoscopy alone, it is difficult to confirm if there is residual tumour remaining or whether the instruments are close to critical structures (e.g. internal carotid arteries) during the surgery, which drastically reduces the effectiveness of treatment due to incomplete resection, and increases risk of irreversible complications from accidental damage. Introducing an additional form of image guidance alongside endoscopy may resolve this, but due to the significantly restrictive surgical space available, the range of imaging modalities that can be deployed are limited. Preoperative imaging modes, such as MRI and CT, offer subsurface view of the surgical site, but these cannot be integrated as real-time intraoperative image guidance in surgery due to large imaging setups and high levels of electromagnetic radiation required. Ultrasound is a non-ionising subsurface imaging modality offering handheld operation and ease of use. Previous attempts to introduce interventional ultrasound have been limited due to bulky probe dimensions (ca. 7 mm in diameter) and undesirable purely forward or side viewing operation, restricting visualisation of all tumours of wildly varying size, geometry and orientation. Instead, we propose a novel way of generating and detecting ultrasound using light, with miniature fibre-optic probes (less than 2 mm in diameter). Unlike current ultrasound imaging alternatives based on electronic transducer technology, optical ultrasound (OpUS) imaging probes are highly flexible, and thus can be paired with articulated surgical tools to enable a customisable field of view and successfully visualise pituitary glands and all tumour growth. This modality not only offers real-time, high resolution, video-rate imaging [2], but also enables articulated, flexible and 3D imaging in such tightly constrained surgical spaces. Here, we present an initial assessment of the applicability of OpUS imaging to interventional pituitary surgery, by demonstrating clinically relevant image quality in both 2D and 3D, assessing thermal safety, and considering practical integration of this technology into the operative workflow.

P04**Cardiovascular Mechanics and Biomedical Imaging****Thursday 3 September 2026** · 14:00-14:20 · Space Six**Chairs:** Dr Riaz Akhtar · Dr Joseph van Batenburg-Sherwood

Effect of Perfluorocarbon Gas Core Composition on Acoustic Attenuation, Ultrasound Imaging, and Condensation Behaviour of Lipid-Shelled Microbubbles for Nanodroplet Development

Miss Paveekorn Supteranon, Dr Helen Mulvana

Scheduled presenter: Miss Paveekorn Supteranon · **Organisation:** University Of Glasgow · **Programme slot:** 14:18-14:20 ·**Display:** Poster stand F · **Paper:** 203

DESCRIPTION OF PROPOSED TALK

Perfluorocarbon (PFC) gas core microbubbles (MBs) are established ultrasound contrast agents with growing theranostic relevance, particularly through their conversion into phase-change nanodroplets (NDs) via condensation. The choice of PFC gas core influences bubble stability, acoustic response, and condensation propensity, yet rational core selection remains an open design question. This study systematically compares octafluoropropane (OFP) and perfluorobutane (PFB) core lipid-shelled MBs with respect to acoustic attenuation, ultrasound imaging enhancement, and ND conversion capacity.

MBs were prepared using DSPC, DSPE, and PEG-40-Stearate dissolved in a chloroform:cyclohexane:ethanol (5:3:2) solvent mixture, dried into a thin lipid film by nitrogen evaporation at 75°C, and hydrated with phosphate-buffered saline. The headspace was evacuated and backfilled three times with either OFP or PFB gas, followed by mechanical agitation (Vialmix®, 45 s). Bulk acoustic attenuation was measured using a calibrated single-element transducer (3.5 MHz) and hydrophone needle (0.2 mm) at 75 mm focal depth across pressure amplitudes of 48-212 kPa over the 2.5-4.5 MHz band, with frequency-domain spectra derived by comparison against a water reference. B-mode ultrasound imaging was assessed under both static and flow phantom conditions. MB size and concentration were confirmed by optical microscopy prior to condensation; MBs were subsequently condensed into NDs by pressurisation at -10°C, and NDs were characterised by nanoparticle tracking analysis.

OFP-MBs produced consistently greater acoustic attenuation than PFB-MBs across all peak negative pressures, consistent with OFP's higher molecular weight and lower gas solubility. B-mode imaging showed comparable enhancement between agents under flow conditions, with marginally greater contrast observed for OFP-MBs in the static phantom. Upon pressurisation, PFB-MBs (mean diameter $2.71 \pm 1.01 \mu\text{m}$) condensed successfully, producing a visually distinct ND phase (mean diameter $100.2 \pm 0.90 \text{ nm}$). In contrast, OFP-MBs (mean diameter $2.27 \pm 0.71 \mu\text{m}$) yielded unclear phase separation under identical conditions, with NTA detecting particles at $157.6 \pm 2.3 \text{ nm}$ but the suspension remaining visually homogeneous, suggesting incomplete condensation yield likely attributable to OFP's lower boiling point and higher vapour pressure [1].

These results demonstrate that gas core identity meaningfully governs MB performance across acoustic, imaging, and phase-change domains. OFP-MBs are better suited to diagnostic applications requiring strong attenuation and imaging contrast, while PFB-MBs show greater promise for phase-change therapeutic strategies. This work supports application-driven PFC gas core selection in the rational design of theranostic MB and ND agents.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

Serotonin Autocalibration: A Multilinear Model to Understand the Relationship between Electrode Length on Signal Output in FSCV with a Series of Serotonin Concentrations

Mr Thomas Burton

Scheduled presenter: Mr Thomas Burton · **Organisation:** Imperial College London · **Programme slot:** 14:00-14:02 · **Display:** Poster stand F · **Paper:** 158

DESCRIPTION OF PROPOSED TALK

Fast scan cyclic voltammetry (FSCV) is an electrochemical technique used in neurotransmitter detection. A dynamic potential is applied to a carbon fibre microelectrode (CFM) which induces electron transfer between analytes of interest and the CFM. This induces a current that is dependent on concentration and provides high spatiotemporal neurotransmitter dynamics. Specifically, this technique enables the validation and quantification of biomarkers in vitro and in vivo models, namely serotonin in models of depression. Notably electrode length has a great effect on signal output where greater surface area increases serotonin adsorption, and thus current. As the CFM fabrication relies on manual cutting of fibres, this introduces electrode length variability between electrodes cut to the same length. Therefore, in this work, we propose the formation of a model to understand the relationship between electrode length and current output for a series of serotonin concentrations. Through the fabrication of electrodes to different lengths (50µm-150 µm), we have performed flow injection analysis (FIA) coupled with FSCV to derive current values at known serotonin concentrations for varying electrode lengths. We then fit a multilinear regression model to quantify the relationship between electrode length and measured current output for a series of serotonin concentrations.

This model addresses variation in data attributed to electrode geometry and enhances the understanding of CFM calibrations that can be utilised in FSCV experiments on human derived stem cell and rodent models. This work will enhance the accuracy and reproducibility of in vitro and in vivo models of depression via removing potential error attributed to electrode cutting. This will enable reproducible biosensing and provide a framework for enhanced biomarker detection using FSCV derived data that is translatable across electrochemistry and neuroscience.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

Association Of Sit-To-Stand /Stand-To-Sit Movements and Functional Ability in healthy people: A pilot study

Mr Mohammad Alsaigh, DR EMAD AL-YAHYA, prof Praminda Caleb-Solly, DR Lucas Fonseca

Scheduled presenter: Mr Mohammad Alsaigh · **Organisation:** Nottingham University · **Programme slot:** 14:02-14:04 ·**Display:** Poster stand F · **Paper:** 91

DESCRIPTION OF PROPOSED TALK

Background

Sit-to-stand (STS) and stand-to-sit (SIT) transitions are essential translational movements that support many daily functional activities. These motions are crucial for autonomous mobility and community engagement, serving as significant indications of an individual's functional capacity. Individuals with disorders frequently exhibit substantial impairments in the capacity to perform STS and SIT movements due to motor, sensory, or cognitive abnormalities, resulting in greater dependency, diminished quality of life, and an elevated risk of falls. Due to their significance in daily activities, STS and SIT transitions are commonly employed in clinical practice as indicators of functional performance. The aim of this pilot study is to assess the reliability and validity of the experimental design and methods in healthy controls prior to application in stroke survivors.

Research questions:

Does STS kinematics have the potential to predict other functional abilities (balance, independence, gait, mobility) and the risk of falling among healthy subjects?

Objectives

1-To establish objective, measurable standards in STS performance which reliably predict functional outcomes (balance, independence, gait, mobility) and the risk.

2- To assess whether IMU data offer further value or improve the prediction efficacy of STS movement in relation to standard parameters.

3- to identify and assess the challenges and barriers faced by stroke survivors during the assessment session

Methodology

The participants (n=10) will be assessed both with and without the stroke simulation suit (SSS) to replicate the challenges encountered by actual stroke survivors. The protocol incorporates the use of Inertial Measurement Units (IMUs) and Electromyography (EMG) to capture biomechanical characteristics of the sit-to-stand (STS) transition during Timed Up and Go (TUG) test and the Five Times Sit-to-Stand Test (5TSTS), including time-domain metrics and kinematic parameters. Outcomes, obtained through IMU and EMG data, focus on quantifying these biomechanical features, particularly time-domain and kinematic measures.

Data analysis:

Data analysis will be performed utilizing IBM SPSS version 27.0.1 on Windows 10. After filtering and eliminating the noise from the raw data, in addition to relevant features were extracted using Python.

Preliminary results:

This study showed that the methods, measuring instruments, and experimental design are feasible and exhibit suitable accuracy and reliability. Several biomechanical aspects of STS performance were successfully captured by IMU and EMG systems. The experimental design was adjusted based on the results of this phase, which improved measurement accuracy and protocol consistency. The outcomes of the ongoing data analysis will be presented at the conference.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

A Chip-Integrated Electrochemical Sensing Platform for Real-Time Serotonin Detection

Miss Naima Adan, Joseph van Batenburg-Sherwood, Parastoo Hashemi

Scheduled presenter: Miss Naima Adan · **Organisation:** Imperial College London · **Programme slot:** 14:04-14:06 · **Display:** Poster stand F · **Paper:** 109

DESCRIPTION OF PROPOSED TALK

Background

Serotonin dysregulation underlies depression, anxiety, and a range of psychiatric disorders, and antidepressant drug discovery would benefit enormously from human cell-based models that resolve serotonin release at the sub-second, low-nanomolar scale at which it signals. Recent work from our group (Bohl et al., 2026) has demonstrated that fast-scan cyclic voltammetry (FSCV) at carbon-fibre microelectrodes (CFMs) can quantify spontaneous and evoked serotonin release from iPSC-derived 3D serotonergic spheroids, and can resolve the differential pharmacology of clinically used SSRIs. However, those measurements rely on manually positioned electrodes in open buffer chambers and are restricted to short, end-point recordings. To translate this capability into a reproducible, scalable tool for drug discovery, the recording interface itself must be re-engineered. Our research goal is to deliver a chip-integrated FSCV platform that brings sub-second human serotonergic readout into a closed, fluidically controlled, reproducible format suitable for higher-throughput pharmacological screening.

The platform: We present an integrated electrochemical sensing platform comprising a PMMA microfluidic chip that traps a single serotonergic spheroid at a funnelled lock-in gate, with a vertical stimulation cap above the trap and an electrode port for axial CFM insertion targeting the spheroid interior. Fluidic performance was validated using a pressure-driven flow system, demonstrating near-ideal linearity across the operating range and confirming that downstream signal variation reflects biology rather than fluidics. Alongside the chip, we have developed a novel electrode strategy designed to overcome the fragility and integration limitations of conventional glass-insulated CFMs in a chip-integrated context. We will present the chip architecture, the fluidic and electrochemical characterisation that defines the platform's operating envelope, and the rationale and validation framework for the electrode development programme.

Impact

The platform offers a closed-system, reproducible, scalable route to serotonergic drug screening in human neural tissue, directly addressing the throughput and sterility limitations that currently constrain benchtop FSCV. The chip architecture is amenable to multiplexing, with parallel spheroid traps and electrode ports enabling simultaneous recording across multiple spheroids for higher-throughput pharmacological studies. Although demonstrated here for serotonin, the FSCV technique and the chip architecture are directly applicable to dopamine, noradrenaline, and other electroactive neuromodulators, broadening the platform's relevance to depression, anxiety, neuroinflammation, and the next generation of CNS therapeutics.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

The development of a device for quantitative assessment of Alzheimer's and Parkinson's Disease progression

Mr Rohan Firat, Miss Ellen Nixon-Anton, Mr Dylan Puri, Miss Koyuki Taylor-Takahashi, Miss Manqi Luo, Mr Callum Scholes, Mr Daniil Zotkin, Mr Ratul Vaish, Dr Davide Piaggio

Scheduled presenter: Mr Rohan Firat · **Organisation:** University of Warwick · **Programme slot:** 14:06-14:08 · **Display:** Poster stand F · **Paper:** 178

DESCRIPTION OF PROPOSED TALK

Neurodegenerative diseases affect roughly 1 million people in the UK and more than 57 million worldwide, with both figures expected to double every 20 years. Conventional evaluation methods lack adequate frequency and provide insufficient quantitative results, and with an aging population the strain on the NHS is only going to increase [1]. We hope to present the theory, design, and development of our innovative method of monitoring neurodegeneration in those suffering from Alzheimer's and Parkinson's Disease (AD and PD).

The Health and Emotion Remote Observation device (H.E.R.O.) aims to alleviate the strain the NHS faces in monitoring neurodegeneration in AD and PD patients and get better quantitative insights into these diseases. Tracking cognitive, autonomic, and motor responses from four interactive tasks over multiple sessions provides a clinician with frequent, pertinent and processed datasets that span long periods of time to best evaluate the state of the illness and its progression. Short, gamified clinically relevant tasks are displayed in a graphical user interface (GUI) to engage the user and avoid cognitive fatigue and skewed results [2].

To get relevant quantitative data, four sensors are integrated in the device, operating simultaneously throughout each session. Following current literature, an EEG (Electroencephalogram) module tracks the long-term cognitive decline captured by the theta-alpha ratio in the temporo-parietal zone [3][4][5]. A remote eye tracking module captures saccades and abnormalities in fixation stability and smooth pursuit, which have been found to be related to neurodegenerative diseases [6]. An accelerometer is implemented to capture potential tremors, which are characteristic of PD, from the frequency response of the signal [7][8][9]. Lastly, a pulse oximeter measures the heart rate and oxygen levels in blood during cognitively demanding tasks to capture fluctuations in blood oxygenation [10].

To validate the independent use of the H.E.R.O. device in care homes and hence alleviate the strain on the NHS and HCPs (Healthcare Practitioners), a usability study was conducted. The results of the usability study showed that only 19% of participants were detractors for the H.E.R.O. device being a self-driven, monitoring device on the Likert scale.

H.E.R.O. is a novel, quantitative method for monitoring neurodegeneration in AD and PD patients without HCPs present. Our device utilises engaging games to stimulate relevant biomarkers. Future work will aim to validate the quantitative biometric results through both an extended usability study and clinical validation study.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

Empowering Locally Deployable Medical Agent via State Enhanced Logical Skills for FHIR-based Clinical Tasks

Mr Wanrong Yang, Dr Zhengliang Liu, Mr Yuan Li, Mr Bingjie Yan, Miss Lingfang Li, Prof Mingguang He, Prof Dominik Wojtczak, Prof Yalin Zheng, Dr Danli Shi

Scheduled presenter: Mr Wanrong Yang · **Organisation:** The University Of Liverpool · **Programme slot:** 14:08-14:10 ·

Display: Poster stand F · **Paper:** 197

DESCRIPTION OF PROPOSED TALK

While Large Language Models demonstrate immense potential as proactive Medical Agents, their real-world deployment is severely bottlenecked by data scarcity under privacy constraints: clinical interaction trajectories are highly sensitive and cannot be used for cloud-based training, while acquiring the annotated multi-turn data required for reinforcement learning is prohibitively difficult. Consequently, traditional approaches that embed environment-specific workflows into model weights are often impractical for locally deployable models facing unseen clinical settings. To overcome this, we propose State-Enhanced Logical-Skill Memory (SELSM), a training-free framework that distills simulated clinical trajectories into entity-agnostic operational rules within an abstract skill space. During inference, a Query-Anchored Two-Stage Retrieval mechanism dynamically fetches these entity-agnostic logical priors to guide the agent's step-by-step reasoning, effectively resolving the "state polysemy" problem. Evaluated on MedAgentBench---the only authoritative high-fidelity virtual EHR sandbox benchmarked with real clinical data---SELSM substantially elevates the zero-shot capabilities of locally deployable foundation models (30B--32B parameters). Notably, on the Qwen3-30B-A3B backbone, our framework completely eliminates task chain breakdowns to achieve a 100% completion rate, boosting the overall success rate by an absolute 22.67% and significantly outperforming existing memory-augmented baselines. This study demonstrates that equipping models with a dynamically updatable, state-enhanced cognitive scaffold is a privacy-preserving and computationally efficient pathway for local adaptation of AI agents to clinical information systems. While currently validated on FHIR-based EHR interactions as an initial step, the entity-agnostic design of SELSM provides a principled foundation toward broader clinical deployment.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

Evaluating power spectral density analysis for Parkinson's Disease tremor

Mr Ross Barnes, Sofia Oliver-Rocha, James Weeks, Ellen Buckley, Thomas Payne, Oliver Bandmann, Tecla Bonci

Scheduled presenter: Mr Ross Barnes · **Organisation:** University Of Sheffield · **Programme slot:** 14:10-14:12 · **Display:** Poster stand F · **Paper:** 213

DESCRIPTION OF PROPOSED TALK

Introduction

In the evaluation of Parkinson's Disease (PD), the Unified-Parkinson's-Disease-Rating-Scale-(UPDRS) is widely used to quantify symptoms but highly subjective presenting a key challenge to clinical trials [1]. Assessments of motor-symptoms such as using wearable inertial sensors may provide more objective outcome measures, however, a standardised approach to assessment is still lacking. This study aims to determine the reliability of tremor-related outcomes derived from wrist-worn wearables.

Methods

Six PD participants were recruited to this study (MoStrAct, REC 19/YH/0221) where MDS-UPDRS-pt-III was completed, including three tasks evaluating tremor: resting-tremor (assessed with arms on lap), postural-tremor (assessed with arms stretched outwards), and action-tremor (assessed with finger-to-nose-manoeuve). These tests were instrumented using the Axivity sensor secured on both wrists resulting in 20 measurements.

Triaxial gyroscope signals (± 2000 deg/s, 100Hz) were split into 3-second windows and labelled tremor/non-tremor [2][3]. Band power (BP) analysis was performed for three frequency bands relating to voluntary [0-3.5Hz], tremor [3.5-7.5Hz] and physiological [7.5-15Hz] movement. For each task, absolute (AP) and relative power (RP) were calculated for each window and band.

To assess the power and tremor-severity relationship within each axis and to include postural and action-tremor, this study adjusted thresholds such as the range for tremor detection [3.5-10Hz], and BP and Root-Mean-Squared-Amplitude (RMS-A) correlations calculated.

Results and Discussion

All windows contained tremor, and correlations (>0.9) observed between all BP and RMS-A established that power is proportional to tremor-severity.

In line with previous observations by Heida-et-al. in the resting-tremor task, ~80% power sat in the tremor-band, with RP inversely proportional to the voluntary and physiological-bands. Meanwhile, during the action-tremor task, an inverse relationship in RP - between the voluntary and tremor-bands - confirmed that a worsening tremor slows voluntary movement.

However, action-tremor may sit across a wider spectrum (3-10Hz), as the RP was similar across tremor and physiological-bands, as previously suggested [4].

During postural-tremor tasks, uniform power distribution across the whole spectrum was observed, revealing that worsening tremor influences the whole spectrum.

Meanwhile, across axes power distributions varied, e.g. Roll contained 20% more power than Pitch and Yaw in the physiological-band. In fact, different axes provided better comparisons of power (0.82), rather than a combined-axis approach (0.75).

Conclusion

Instrumentation with inertial sensors, now allows the objective assessment of postural-tremor and action-tremor tasks with axis-level evaluation allowing differentiation of tremor-types and severity-levels. Future work aiming to modify and combine methodologies, will enable a uniform approach to symptom characterisation.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

Automatic Difficulty Setting of Dual Tasks During Gait

Ms Judie Madi, Dr Craig Childs

Scheduled presenter: Ms Judie Madi · **Organisation:** University Of Strathclyde · **Programme slot:** 14:12-14:14 · **Display:** Poster stand G · **Paper:** 232

DESCRIPTION OF PROPOSED TALK

Introduction

Cognitive-motor interference during walking is increasingly recognised as an important marker of neurological function, yet many existing dual-task paradigms rely on fixed cognitive difficulty, manual intervention and limited real-time adaptability.

This study presents the development and evaluation of an adaptive, voice-controlled Stroop system integrated within a Computer Assisted Rehabilitation Environment (CAREN) to enable personalised cognitive-motor assessment during gait.

Methods

A closed-loop framework, designed for real-time cognitive-motor assessment, integrated speech recognition, motion-capture technology, and adaptive task control. Cognitive performance was assessed using the Stroop Colour word Test, in which participants identified the ink colour of visually presented colour words while disregarding the automatic tendency to read the text [1]. Spoken responses were continuously fed back to the system to adjust task difficulty throughout testing.

Offline speech recognition was implemented using Vosk, a locally deployed speech-recognition engine embedded within Python. Prior to participant testing, technical validation and bench-testing procedures were conducted to evaluate system performance and reliability. Seven healthy adults completed walking-only, Stroop-only, and adaptive dual-task (walking and performing Stroop test simultaneously), conditions within the CAREN environment.

Results

The adaptive algorithm successfully modified stimulus timing in response to participant performance, demonstrating real-time behavioural adaptation during gait. Dual-task conditions produced greater variability in response timing and reduced temporal synchronisation compared with seated Stroop performance, suggesting increased cognitive-motor demand during walking. Cadence decreased during dual-task trials, whereas step length remained comparatively stable, indicating that temporal gait measures may be more sensitive to cognitive load than spatial parameters in healthy adults.

A customised pronunciation dictionary improved recognition reliability across participants, while bench testing demonstrated high conditional classification accuracy and confirmed that hardware communication delays contributed minimally to overall system latency. The findings also revealed several interesting interactions between speech processing, task adaptation, and gait behaviour that demand further investigation.

Discussion

This work demonstrates the feasibility of integrating adaptive cognitive testing, speech recognition, and gait analysis within a single immersive platform. The findings highlight both the opportunities and challenges associated with real-time adaptive dual-task assessment and provide insight into the practical considerations required for speech-driven cognitive-motor testing. Overall, this study provides a proof of concept for a personalised adaptive dual-task platform capable of linking cognitive performance directly to gait behaviour in real time and establishes a foundation for future clinical and rehabilitation applications.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

Complexity and Variability in Gait Characterised via Multivariate State Space Analysis

Dr Philip Riches, Mr Jon Clarke, Mr Fahd Mahmood, Mr David Wallace, Dr Lauren Forsyth

Scheduled presenter: Dr Philip Riches · **Organisation:** University Of Strathclyde · **Programme slot:** 14:14-14:16 · **Display:** Poster stand G · **Paper:** 225

DESCRIPTION OF PROPOSED TALK

Measures such as the largest Lyapunov exponent and correlation dimension have been applied to gait data to identify differences between experimental groups, but have seen limited translation into clinical practice. Such measures involve delay-embedding univariate reconstructions of state-space assuming Takens' theorem. However, analysing the state-space constructed directly from multivariate joint kinematic data may offer comparable analytical capability with enhanced clinical interpretability.

This research describes a set of novel multivariate measures to characterise the complexity and variability of cyclic motion appropriate for n-dimensional state space, with specific application to gait analysis. We define cyclic state measures such as mean path length and path tortuosity quantify movement complexity, while variability is assessed through both stride-to-stride fluctuations and a global measure of state space dispersion.

The method is generic and many variables, both kinematic and kinetic, could be considered appropriate for the description of the state space. However, to demonstrate the utility of the approach, lower-body kinematics are analysed holistically within an 18-dimensional framework, comprising the three joint angles of the ankle, knee, and hip bilaterally. In doing so, we maintain in the state space inter-joint dependencies and temporal coordination patterns that are inherently lost in univariate or lower-dimensional approaches. The proposed measures are evaluated across 11 younger adults (m/f: 9/2), 14 older adults (m/f: 4/10), and 7 individuals following total knee arthroplasty (m/f: 3/4).

The ratio of stride-to-stride variability to overall state space variability reduced with ageing ($p = 0.008$) and following arthroplasty ($p < 0.001$). This suggests a compensatory adaptation in gait, whereby individuals subconsciously regulate movement to enhance local joint stability within the bounds of intrinsic variability. Females demonstrated a longer path length in 18-dimensional state space suggesting a greater complexity of movement ($p = 0.032$) in addition to a greater variability ratio ($p = 0.037$).

Although small in scale, these findings demonstrate the potential of multivariate, high-dimensional state space analysis to provide sensitive and clinically meaningful insights into gait organisation avoiding the need for more abstract measures such as Lyapunov Exponent and Correlation Dimension. Further, this approach may support the development of robust biomechanical biomarkers for identifying and monitoring pathological gait and joint instability in clinical populations.

P05**Clinical Diagnostics****Thursday 3 September 2026** · 14:00-14:18 · Space Seven**Chairs:** Professor Raoul van Loon · Dr Javad Sarvestan

Beyond Mean Alpha Power: Alpha-Band EEG Temporal Dynamics and Balance Impairment in People with Parkinson (PwP)

Mr Abubakar Muhammad, Dr Hajun Yoon, Assoc. Prof Qadeer Arshad, Reader Tim Pearce

Scheduled presenter: Mr Abubakar Muhammad · **Organisation:** University Of Leicester · **Programme slot:** 14:16-14:18 ·**Display:** Poster stand G · **Paper:** 137

DESCRIPTION OF PROPOSED TALK

Alpha-band EEG activity is typically summarized using mean power, which may overlook clinically relevant temporal dynamics in people with Parkinson's disease (PwP). We quantified alpha-band power spectral density (PSD) and derived features capturing magnitude, variability, entropy, bursting behaviour, and state transitions. Temporal structure was further characterized using binned alpha PSD trajectories, discrete cosine transform (DCT), discrete wavelet transform (DWT), and nonlinear metrics. Associations with clinical outcomes were assessed using Spearman correlation with false discovery rate (FDR) correction, while temporal modulation was evaluated using a binned mixed-effects model of log-transformed alpha PSD. In 45 PwP performing exergaming, alpha power increased significantly across normalized epoch bins, indicating structured temporal modulation over time. Among the clinically assessed measures (UPDRS-III, BERG, Mini-BESTest, and PDQ-39), balance performance indexed by the BERG score showed the strongest association with alpha features. BERG scores were negatively correlated with log median alpha PSD ($\rho = -0.528$, FDR $p = 0.0055$), MAD PSD ($\rho = -0.507$, FDR $p = 0.0055$), trajectory mean ($\rho = -0.505$, FDR $p = 0.0055$), IQR PSD ($\rho = -0.458$, FDR $p = 0.0159$), and first-to-last trajectory change ($\rho = -0.412$, FDR $p = 0.0407$). The binned mixed-effects model also showed a significant positive epoch-bin effect on log alpha PSD (coefficient = 0.022, $p < 0.001$). These findings suggest that alpha-band temporal dynamics, particularly magnitude and variability, are associated with balance impairment in PwP. Transform-based trajectory features did not survive correction but may still offer complementary multi-scale characterization of alpha activity and support further development of temporal EEG markers for motor function assessment in PwP.

P06**Tissue Engineering and Women's Health****Thursday 3 September 2026** · 14:00-14:14 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Loss of LSD1 Rewires Transcriptional Control of Mammalian Gastrulation by Disruption to Embryonic Axis Formation

Miss Leona Irwin, Dr David English, Mr Mahesh Ola, Dr Himanshu Kaul, Professor Shaun Cowley

Scheduled presenter: Miss Leona Irwin (Dr Himanshu Kaul) · **Organisation:** University Of Leicester · **Programme slot:** 14:00-14:02 · **Display:** Poster stand G · **Paper:** 82

DESCRIPTION OF PROPOSED TALK

Histone modifications are fundamental to timely gene expression and the determination of cell fates. However, the biological significance of such modifications in early post-implantation development have been difficult to decipher for many years. Lysine-specific demethylase 1 (LSD1) is a vital regulator of transcriptional gene repression with essential roles in mammalian development. Its early embryonic lethality at the time of gastrulation (E6.5), have previously hindered investigations. To decipher the role of LSD1 during this critical window of development, we have implemented a degradation tag (dTAG) system within mouse embryonic stem cells (mESCs). Using time-resolved depletion of LSD1 and RNA-sequencing, we show the direct genetic consequences of LSD1 loss within gastruloids. Removal of LSD1 consequentially results in the failure of axial elongation at 120h, with defective convergent extension. Integrating transcriptomic data and mathematical modelling via SCING, this deficiency was observed at the molecular level within dysfunctional Nodal, Wnt, and Retinoic acid gene regulatory networks (GRNs). Depletion of LSD1 at the time of gastrulation results in the dysregulation of germ layer patterning and perturbs underlying embryonic GRNs required for embryonic axial patterning. This interdisciplinary work has enabled us for the first time to identify time-resolved LSD1-dependent signalling networks during embryonic gastrulation.

P06**Tissue Engineering and Women's Health****Thursday 3 September 2026** · 14:00-14:14 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Microphysiological modelling of neuro-tumour communication: a biocomputing analysis of micropatterned co-culture platform on micro-electrode array

Mr Ali Pourrouholamin, Dr Michael Barros, Dr Andrea Mohr, Prof Reinhold Scherer

Scheduled presenter: Mr Ali Pourrouholamin · **Organisation:** University Of Essex · **Programme slot:** 14:02-14:04 · **Display:** Poster stand G · **Paper:** 59

DESCRIPTION OF PROPOSED TALK

Crosstalk between the nervous system and tumour cells is increasingly recognised as a key driver of cancer progression, influencing proliferation, invasion, and treatment resistance. Despite growing mechanistic evidence from in vivo models, the functional electrophysiological dimension of this bidirectional communication remains poorly characterised in controlled in vitro settings. Existing co-culture systems largely lack the spatial precision needed to decouple contact-mediated from paracrine signalling modes, and few platforms provide simultaneous electrophysiological readout with sufficient resolution to capture network-level neuro-tumour dynamics.

We investigate how to address this gap through the development of a microphysiological model in which bioprinted, micropatterned neural tissues are co-cultured with cancer cells on micro-electrode arrays (MEAs), enabling real-time recording and stimulation of neuro-tumour signalling. Neurons are differentiated and deposited onto MEA substrates using micropatterning techniques that define the spatial geometry of neural clusters and their proximity to cancer cells. This controlled architecture allows systematic investigation of how physical distance and cellular configuration modulate the electrophysiological signature of neuro-tumour interaction.

Evidence in the literature demonstrates that cancer cell-conditioned environments alter neuronal excitability, spontaneous firing rates, and network synchrony, with studies reporting synapse-like structural connections between neurons and tumour cells. However, the directionality and information content of these interactions - whether neurons predominantly drive tumour behaviour or vice versa - remains unresolved. This study therefore targets the directionality and information content of neuro-tumour signalling as its central research question, an aspect that remains largely unresolved in existing in vitro literature.

By introducing cancer cells into defined proximity of established neural networks on the MEA, we record changes in spontaneous and evoked electrophysiological activity attributable to neuro-tumour co-culture. A biocomputing analysis pipeline is applied to characterise how molecular inputs and paracrine signalling modulate the information processing capacity of the neural population. By systematically examining the input-output relationship of the neural network under co-culture conditions, we employ information theory, including transfer entropy and signal separability, to quantify the rate and directionality of information transfer between neural and tumour-coupled nodes.

The experimental design is positioned to uncover structured, asymmetric information processing patterns consistent with emerging evidence on neural regulation of the tumour microenvironment. Beyond mechanistic insight, the platform offers a scalable in vitro tool for studying neuro-tumour interactions in pharmacologically relevant contexts, with potential applications in cancer drug screening and the design of electroceutical interventions targeting tumour-associated neural circuitry.

P06**Tissue Engineering and Women's Health****Thursday 3 September 2026** · 14:00-14:14 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Developing a magnetic nanoparticle-based workflow for remote mechanotransduction in bone tissue engineering

Miss Yuxuan Du, Professor Alicia El Haj

Scheduled presenter: Miss Yuxuan Du · **Organisation:** University of Birmingham · **Programme slot:** 14:04-14:06 · **Display:** Poster stand G · **Paper:** 131

DESCRIPTION OF PROPOSED TALK

Mechanical stimulation is important for bone repair, but it is still difficult to deliver a defined mechanical cue to cells in a local and controllable way. Magnetic ion channel activation (MICA) offers one possible approach, using functionalized magnetic nanoparticles that can be actuated remotely by an external magnetic field to influence mechanosensitive pathways.

My project focuses on developing a more reproducible MICA workflow for bone tissue engineering. Rather than treating magnetic stimulation as a single step, I am looking at the full system: nanoparticle formulation, antibody or ligand functionalization, particle behavior in biological media, degradation/iron release, and downstream biological readouts. This is important because particle aggregation, serum effects or poor target access can make it difficult to interpret reliability and reproducibility of mechanotransduction related activation.

So far, I have been working on comparing magnetic nanoparticle constructs, improving the functionalization and control strategy of antibody, and redesigning an ICP-OES workflow to assess iron release. In parallel, signaling assays are being optimized to define suitable timing windows before moving towards longer term osteogenic readouts. In this presentation, I will show the developing workflow, preliminary iron release analysis, and the control strategy being used to make MICA experiments more comparable and interpretable for future bone tissue engineering studies.

P06**Tissue Engineering and Women's Health****Thursday 3 September 2026** · 14:00-14:14 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Hybrid PCL/GelMA Scaffolds Fabricated via RIFLE for Biomimetic Cartilage Tissue Engineering

Mr Mohammed Albiloushi, Dr. Will Shu

Scheduled presenter: Mr Mohammed Albiloushi · **Organisation:** University Of Strathclyde · **Programme slot:** 14:06-14:08 ·**Display:** Poster stand G · **Paper:** 220

DESCRIPTION OF PROPOSED TALK

Articular cartilage possesses limited intrinsic healing capacity due to its avascular and aneural structure, while current clinical interventions often fail to restore long-term mechanical and biological functionality. Tissue-engineered hybrid scaffolds combining mechanically robust synthetic polymers with biologically active hydrogels represent a promising strategy for cartilage regeneration. This study proposes a biomimetic hybrid construct integrating extrusion-based 3D-printed polycaprolactone (PCL) scaffolds with gelatin methacryloyl (GelMA) hydrogels to better replicate the middle zone of native articular cartilage.

The work introduces Rotational Internal Flow Layer Engineering (RIFLE) as a novel hydrogel infiltration approach for porous synthetic scaffolds. Unlike conventional static or pressure-driven infiltration methods, RIFLE enables controlled rotational flow and layered hydrogel deposition within scaffold pores, potentially improving penetration uniformity, reducing pore occlusion, and enabling spatially organized hydrogel distribution. Porous PCL scaffolds will be fabricated using direct ink writing (DIW), while GelMA hydrogels will be prepared using photo-crosslinkable formulations with LAP photoinitiator. RIFLE processing parameters, including rotational speed, hydrogel viscosity, and UV curing conditions, are being systematically optimized.

Constructs were characterized using rheological analysis, compressive mechanical testing, microscopy to evaluate structural integrity, hydrogel distribution, and cartilage-mimetic properties. Preliminary biological assessment will investigate cell viability and early chondrogenic behaviour within the hybrid scaffold system.

This study aims to establish a new hybrid biofabrication strategy that combines mechanical reinforcement, hydrogel bioactivity, and controlled internal organization to address current limitations in cartilage tissue engineering. The integration of RIFLE with porous scaffold fabrication may provide a versatile platform for developing stratified tissue-engineered constructs for cartilage and other hierarchical tissues.

P06**Tissue Engineering and Women's Health****Thursday 3 September 2026** · 14:00-14:14 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Using 3D Bioprinted hiPSC-derived Engineered-Heart-Tissues as a Human Model to Study Variants Associated with Arrhythmia Development

Ms Sanjana Singh

Scheduled presenter: Ms Sanjana Singh · **Organisation:** Bc Children's Hospital Research Institute & School Of Biomedical Engineering At Ubc · **Programme slot:** 14:08-14:10 · **Display:** Poster stand H · **Paper:** 224

DESCRIPTION OF PROPOSED TALK

Atrial fibrillation (AF) is typically triggered by ectopic activity, causing disorganized cardiac rhythm and contributing to substantial morbidity and mortality. Recent studies have identified a KCNN3 variant that alters the small-conductance Ca^{2+} -activated K^+ (SK3) channel, a key regulator of cardiac rhythm. The variant is predicted to remodel action potential duration (APD), calcium handling, conduction, and various electrophysiological properties, but its tissue-level effects remain poorly understood. Current models, including 2D monolayers and animal models, lack human atrial architecture, physiological mechanical loading, and scalability, limiting mechanistic genotype-to-phenotype inference and translational drug testing. This study will engineer patient-relevant atrial engineered-heart-tissues (EHTs) using human induced pluripotent stem cells (hiPSCs) to provide a platform to evaluate how this variant may contribute to the development of AF. We will generate atrial EHTs using a standardized 3D bioprinting workflow that anchors tissues between flexible posts to impose defined geometry and mechanical preload. This architecture is expected to improve electrophysiological fidelity by promoting cardiomyocyte alignment, cell-cell coupling, and reproducible wave propagation, enabling robust measures of the disturbed electrical properties. Concurrently, EHT post deflection enables non-destructive quantification of contractile function, which is important because SK3-associated electrophysiological remodeling may impair excitation-contraction coupling in ways not captured by electrical indices alone. By applying high-speed optical mapping with voltage and calcium imaging, alongside contractile assessment, we aim to establish a validated, reproducible platform linking genotype to tissue-scale phenotype to help identify intervention strategies.

P06**Tissue Engineering and Women's Health****Thursday 3 September 2026** · 14:00-14:14 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Development of a Microfluidic Particle-Tracking Platform for Characterising Soft Gel Mechanics

Mr chris ashley

Scheduled presenter: Mr chris ashley · **Organisation:** University Of Liverpool · **Programme slot:** 14:10-14:12 · **Display:** Poster stand H · **Paper:** 122

DESCRIPTION OF PROPOSED TALK

Understanding how soft biological materials behave mechanically is important for areas like biomaterials, mechanobiology and cell biology. In this work, a microfluidic particle-tracking platform was developed to study soft gels using passive microrheology. The method works by tracking the Brownian motion of embedded 2 μm carboxylate polystyrene beads, where changes in bead movement can be related to how restrictive or gel-like the surrounding material has become.

Alginate was used as the first model system because it forms a simple hydrogel and is useful for developing the method before applying it to more complex biological systems, such as filamentous protein networks. The tracer beads were coated with PLL-g-PEG to reduce sticking and improve dispersion. Flow cells were made using glass slides, coverslips and Parafilm spacers, with PEG-DA hydrogel membranes formed using local UV exposure. Bead motion was then recorded by microscopy and analysed using particle trajectories, mean squared displacement, diffusion coefficients, van Hove distributions and storage/loss modulus calculations.

The early results show that bead motion can be tracked inside the microfluidic gel system and that changes in movement can be measured as the gel forms. Static error correction helped improve the MSD data at short lag times, while diffusion coefficients and van Hove analysis gave further information about how particle motion changed over time. The MSD data was also used to estimate storage and loss moduli, showing a transition from more viscous behaviour towards more elastic gel-like behaviour.

P06**Tissue Engineering and Women's Health****Thursday 3 September 2026** · 14:00-14:14 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Beyond Diameter: Sex-specific AAA wall composition and micro-mechanics to improve rupture risk assessment in UK patients

Ms Gemma Pace

Scheduled presenter: Ms Gemma Pace · **Organisation:** University Of Liverpool · **Programme slot:** 14:12-14:14 · **Display:** Poster stand H · **Paper:** 81

DESCRIPTION OF PROPOSED TALK

This poster will present a translational biomedical engineering study investigating whether sex-specific differences in abdominal aortic aneurysm wall composition and micromechanical behaviour contribute to rupture risk beyond maximum aneurysm diameter. The work is based on the clinical observation that women with abdominal aortic aneurysm experience poorer outcomes than men and may rupture at smaller diameters, suggesting that current diameter-based risk assessment may not adequately capture individual rupture risk.

The poster will outline the rationale, aims and proposed methodology of the study. Human abdominal aortic aneurysm wall specimens collected during open surgical repair will be analysed using quantitative histology, whole-slide image analysis and nanoindentation-based micromechanical mapping. Staining methods including H&E, Picrosirius Red, Verhoeff-Van Gieson and Alcian Blue will be used to assess elastin, collagen, glycosaminoglycans, cellularity and structural degeneration. Mechanical properties, including reduced modulus and hardness, will be mapped locally and related to tissue composition. Where available, these findings will also be integrated with CT-derived anatomical features and finite-element wall stress modelling.

The poster will highlight how combining tissue biology, biomechanics and imaging could support the identification of a sex-informed high-risk aneurysm wall phenotype. This may provide mechanistic evidence for improving abdominal aortic aneurysm surveillance and repair strategies, particularly for women, and supports the wider biomedical engineering aim of developing more personalised and clinically relevant approaches to rupture-risk assessment.

P07**Metamaterials for Health****Thursday 3 September 2026** · 14:14-14:18 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Assessing of the cybersecurity resilience of diabetes technology

Dr Anna Bird, Dr Vivek Mohan, Mr Zong Cao, Ms Kexin Wei, Mr Shi Hoe Ng, Ms Manasvi Mulay, Dr Viktor Schlegel, Mr Miro Moffett, Prof Nick Oliver, Prof Anil Bharath

Scheduled presenter: Dr Anna Bird · **Organisation:** Imperial Global Singapore · **Programme slot:** 14:14-14:16 · **Display:** Poster stand H · **Paper:** 79

DESCRIPTION OF PROPOSED TALK

The increasing connectivity of medical devices has enabled remote monitoring, continuous data-driven diagnosis, and more responsive clinical care [1]. However, this has exposed a multilayered cybersecurity attack surface spanning hardware, software, and network interfaces. This risk is not theoretical. A 2018 cyberattack targeting healthcare services in Singapore compromised 1.5 million patient records [2], and a 2024 attack on a pathology service provider in the UK led to severe delays in delivery of patient care [3].

Addressing cybersecurity in the healthcare sector poses unique challenges. Legacy devices, which were approved under previous regulatory guidance but are still in operation, often have inherent vulnerabilities. Remedial action, such as software patching or even replacement of equipment, may not be possible. Regulatory bodies were slow to respond, with EU Medical Device Regulation introducing cybersecurity guidelines in 2017, and the US Food and Drug Administration following in 2023 [4].

This work presents a resilience-oriented framework for the cybersecurity assessment of connected diabetes medical devices. Diabetes technology serves as an excellent exemplar for healthcare cybersecurity, because automated insulin delivery (AID) systems rely on passive continuous glucose monitor sensors (CGM) and active drug delivery devices (insulin infusion pumps), which communicate wirelessly.

To operationalise this framework, we developed a hardware-in-the-loop platform in which physiological glucose conditions are dynamically reproduced in a flow cell using controlled buffer-glucose mixing. Commercial continuous glucose monitors (CGM) are mounted on the system and interfaced with external applications and communication pathways, while outputs are coupled to an in silico patient model. This architecture enables controlled testing of technical faults and adversarial perturbations, including manipulated readings, delayed transmission, communication loss, and discrepancies between licensed and third-party applications. Because the platform captures both device behaviour and downstream physiological consequences, it supports evaluation of cybersecurity not only as technical compromise but as system-level resilience.

The technical novelty lies in combining layered attack-surface analysis with cyber-physical experimentation to move beyond static vulnerability enumeration. Rather than assessing security properties in isolation, the framework measures how disruptions originating in hardware, software, or network domains propagate through connected sensing systems and affect safety-relevant performance. Although demonstrated on CGMs, the methodology is designed to be transferable to other connected medical devices that couple embedded computation, wireless communication, and clinically actionable outputs. This provides a pathway toward reproducible, comparative, and clinically grounded cybersecurity benchmarking for next-generation medical devices.

P07**Metamaterials for Health****Thursday 3 September 2026** · 14:14-14:18 · Wolfson Lecture Theatre**Chairs:** Prof Gwendolen Reilly · Dr Lucy Bosworth

Evaluation of Transtibial Prosthetic Socket Performance Using Multi-Material Additive Manufacturing

Dr Sattam Alharbi

Scheduled presenter: Dr Sattam Alharbi · **Organisation:** Bournemouth University · **Programme slot:** 14:16-14:18 · **Display:** Poster stand H · **Paper:** 155

DESCRIPTION OF PROPOSED TALK

Lower limb prosthetic sockets are critical for restoring mobility in transtibial amputees. Traditional socket fabrication is labour-intensive, dependent on clinician expertise, and often results in poor fit due to the rigid structure of the socket. Multi-material additive manufacturing (MMAM) offers the potential to combine rigid and flexible materials within a single socket, enabling region-specific stiffness tailored to the anatomy of the residual limb. However, despite its conceptual promise, no studies have experimentally evaluated the structural performance of MMAM sockets under standardised mechanical loading. This research aims to address this gap by evaluating the structural performance of transtibial prosthetic sockets fabricated using MMAM under loading conditions.

A multi-phase methodology was adopted. First, a scoping review following PRISMA-ScR guidelines mapped 46 studies on additive manufacturing of lower limb prosthetic sockets across five databases. The review confirmed that MMAM designs remain at the proof-of-concept stage, with no experimental mechanical testing reported under standardised conditions. Second, the mechanical properties and print-to-print repeatability of acrylonitrile styrene acrylate (ASA) were characterised as a candidate structural material. ISO 527-2 Type 1B tensile specimens were fabricated using fused filament fabrication (FFF) in two raster orientations (0°/90° and ±45°) and tested under quasi-static loading with full-field strain measurement via 3D digital image correlation (DIC). Third, the ongoing phase involves the design and fabrication of transtibial sockets using MMAM, incorporating soft material inclusions within rigid socket walls. These sockets will undergo structural testing under static loads, with DIC employed to capture surface strain distribution and deformation behaviour.

Material characterisation demonstrated that FFF-printed ASA exhibits good mechanical repeatability, with coefficient of variation values $\leq 5\%$ for ultimate tensile strength, yield stress, and Young's modulus in both raster orientations. The $\pm 45^\circ$ orientation showed superior mechanical repeatability, while the 0°/90° orientation provided closer dimensional accuracy to the nominal geometry. These findings establish ASA as a suitable candidate material for prosthetic socket prototyping and provide the foundation for the socket fabrication and testing phase currently underway.

This research contributes novel empirical data on the structural performance of MMAM prosthetic sockets. The findings are expected to inform the development of more personalised prosthetic solutions, enabling the design of sockets that better accommodate the anatomical and biomechanical needs of individual amputees.

Friday 4 September 2026

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Evaluating the Predictive Accuracy and Muscle Activation Performance of Hill-Type Multi-Body Dynamic Models of Human Mastication

Dr Andrew Cuff, Mr Thomas Baird, Dr Alana Sharp, Dr Laura Fitton

Scheduled presenter: Dr Alana Sharp · **Organisation:** University of Liverpool · **Programme slot:** 09:10-09:12 · **Display:** Poster stand H · **Paper:** 5

DESCRIPTION OF PROPOSED TALK

Musculoskeletal modelling is an important tool for studying skeletal biology and behaviour. However, recent studies show that models do not accurately represent muscle masses for different age or sex groups, especially for females. New methods for collecting experimental data have made biomechanical model construction increasingly accessible; however, it remains critical to ensure models are valid and that outputs match empirical observations. In this study, we develop a protocol to create multibody dynamic analyses (MDA) of the human skull using an adult male and female participant. Subject specific models were created using magnetic resonance images, and experimentally measured bite force, electromyography (EMG) and kinematic data. Within SIMM, EMG and kinematic data were used to evaluate force outputs, while in OpenSim, force and kinematic data were used to assess muscle activation patterns. Model performance showed generally good agreement in force magnitudes for incisor bites at lower gape values in both sexes, as well as for post-incisor bites in the female model. Trends in force variation along the tooth row were also well replicated to in vivo data. However, the models underestimated peak forces in the male participant and overestimated passive contributions at larger gapes in both models. In contrast, muscle activation patterns were more difficult to replicate, with limited agreement in both the timing and magnitude of activations across muscle strands. There are very few MDA models of the human skull, and the complexities of the masticatory muscles are less well examined than the locomotor system; as such, validating the MDA models proved challenging. Our results add to the literature that highlights the challenges and discrepancies in validating musculoskeletal models, especially considering sex differences. Although further development is required before these models have a predictive use, the methods and protocols presented here provide a robust foundation for future work.

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Gearing up for better motion: the effect of total wrist replacement on muscle moment arms and mechanical efficiency

Miss Sohini Sarbadhikari, Dr Matthew Dempsey, Dr Joanna Glanville, Professor Karl Bates, Mr Ashley Newton, Dr Sebastiano Fichera, Mr Daniel Brown

Scheduled presenter: Miss Sohini Sarbadhikari · **Organisation:** Institute Of Life Course And Medical Sciences, University Of Liverpool · **Programme slot:** 09:12-09:14 · **Display:** Poster stand H · **Paper:** 22

DESCRIPTION OF PROPOSED TALK

Total wrist arthroplasty simplifies the complex, multi-joint structure of the wrist into a single ball-and-socket articulation that potentially alters the mechanical efficiency of the surrounding musculature. This is particularly relevant in the treatment of wrist osteoarthritis, which commonly affects older individuals and often requires surgical intervention. However, the biomechanical relationship between implant-induced changes in muscle-joint geometry and functional mechanical performance remains poorly understood.

The aim of this study is to quantify how total wrist arthroplasty alters muscle moment arms and to examine how these changes relate to mechanical efficiency during functional wrist motion. Anatomically accurate models were developed from computed tomography scans of cadaveric specimens and implemented within a simulation framework to quantify muscle moment arms during flexion-extension and radial-ulnar deviation. Measurements from anatomical and implanted conditions were compared with corresponding actuator forces recorded from cadaveric specimens mounted on a wrist motion simulator.

Preliminary results demonstrate a consistent pattern in flexion-extension across all analysed specimens, with increases in flexor moment arms and decreases in extensor moment arms, explaining altered mechanical efficiency observed in cadaveric motion simulations following implantation. In contrast, changes in moment arms during radial-ulnar deviation were variable and did not exhibit a simple relationship with mechanical efficiency. These findings indicate that total wrist arthroplasty alters the mechanical balance of the wrist in complex ways, and further research is required to inform strategies to improve surgical outcomes.

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Design and Development of a Low-Cost Wearable Shoulder Exoskeleton for Stroke Rehabilitation

Miss Faria Riaz Tabassum

Scheduled presenter: Miss Faria Riaz Tabassum · **Organisation:** Independent · **Programme slot:** 09:14-09:16 · **Display:** Poster stand I · **Paper:** 72

DESCRIPTION OF PROPOSED TALK

Stroke rehabilitation relies heavily on repetitive and consistent upper limb therapy, yet access to specialised services is often limited by cost, waiting times, and workforce constraints. To address these challenges, this study presents the design and preliminary evaluation of a lightweight wearable shoulder exoskeleton intended to support flexion and extension of the upper arm during recovery.

The system uses a single degree of freedom assistive mechanism driven by a DC motor providing a torque of 1.51 N·m at 29.65 RPM. Motion is captured using an inertial measurement unit and processed through an Arduino Mega 2560 to enable adaptive control based on voluntary user movement. This approach is designed to encourage active patient participation by providing assistance that responds to intended motion rather than fully autonomous actuation. The device was developed with accessibility in mind using rapid prototyping methods. The main structure was fabricated using FDM 3D printing in PLA, while functional components were produced in ABS. The total build cost for electronics and fabrication was kept below 120 pounds, demonstrating potential for low cost deployment.

Initial testing with users indicated good levels of comfort, fit, and wearability, supporting the feasibility of extended use in non clinical settings. Observations from this evaluation highlighted areas for improvement including motor housing stability and joint alignment, which will be addressed in future iterations. Although still in early development, the system provides preliminary evidence of safe and practical operation in a wearable format. This work introduces a low cost and user initiated control strategy for shoulder exoskeletons that enables adaptive assistance based on voluntary movement. In contrast to many existing systems that remain expensive and clinic bound, this approach aims to support more accessible home based rehabilitation. By combining affordable fabrication with real time motion sensing, the proposed device offers a practical step towards improving continuity of care and increasing therapy frequency outside clinical environments.

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

A Systematic Review of Human Limb Muscle Architecture and Function: Current Approaches, Trends, and Gaps in the Literature

Miss Ana Constanza Hernandez Romero, Roger Kissane, James Charles, Daniel Brown, Karl Bates

Scheduled presenter: Miss Ana Constanza Hernandez Romero · **Organisation:** University of Liverpool · **Programme slot:** 09:16-09:18 · **Display:** Poster stand I · **Paper:** 141

DESCRIPTION OF PROPOSED TALK

Muscle architecture describes the structural organisation of muscle fibres and is fundamental to determining muscle force-generating properties and overall function. Accurately measuring these properties is therefore essential for valid predictions of skeletal muscle function. Muscle architecture is not static; it remodels in response to activity levels, with adaptations such as hypertrophy following training or atrophy during unloading. Ageing is also associated with declines in muscle mass and function, contributing to increased risk of mortality, mobility impairments, and reduced quality of life. While muscle ageing has been investigated from both morphological and functional perspectives, and physical activity is recognised as a key mitigating factor, understanding the dynamic changes in muscle form and function, as well as the temporal relationships between architectural and functional adaptations, remains challenging due to methodological variation across studies. Here, we present a systematic review examining the current state of the literature surrounding muscle architecture. This systematic review was conducted and reported in accordance with the PRISMA guidelines using the PubMed, Web of Science, and Scopus databases. The search combined terms associated with muscle architecture, function, and activity or disuse, using Boolean operators, and was limited to human limb studies in adult populations (≥ 18 years), published in English, and available up to November 2025. Analysis of the included studies identified consistent trends, notably a strong bias towards healthy young untrained male participants (54.5%), a predominance of lower limb research (89.3%) over the upper limb, and repeated focus on specific muscles such as the vastus lateralis (VL) (19.9%) and rectus femoris (RF) (11.4%), with comparatively limited investigation of other muscle groups. These findings highlight important gaps in the literature, such as the underrepresentation of upper limb studies, despite their potential to provide insights into functionally relevant movements associated with maintaining independence and quality of life during ageing. They also underscore the need for more inclusive research practices, including improved representation of females in muscle architecture studies, as sex-specific factors such as hormonal fluctuations and menopause may influence muscle ageing and adaptation and are currently underexplored.

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

A Simplified Beam Model for Rapid Assessment of Femoral Biomechanics

Miss Shujia Jiang, Dr Matthew Banger, Professor Alison McGregor, Dr Andrew Phillips

Scheduled presenter: Miss Shujia Jiang · **Organisation:** Imperial College London · **Programme slot:** 09:18-09:20 · **Display:** Poster stand I · **Paper:** 192

DESCRIPTION OF PROPOSED TALK

Background

Bone adaptation is governed by mechanical loading, with strain stimulus influencing regions of bone remodelling, osteoporosis and fracture risk, particularly in the proximal femur[1]. Conventional clinical measures such as bone mineral density fail to capture spatial variations in mechanical demand, while high-fidelity finite element models are computationally expensive and unsuitable for rapid evaluation of multiple loading scenarios[2], [3]. There remains a need for efficient modelling approaches that can approximate the biomechanical behaviour of the femur under varied physiological activities.

This study presents a simplified beam-element representation of the femur to enable rapid (near real-time) estimation and visualisation of internal force and moment distributions and resulting stress and strain distributions. By using joint contact and muscle forces derived from musculoskeletal models as inputs, loading conditions from multiple activities can be evaluated quickly, with the resulting visualisations enabling discussions between patients, clinicians, and engineers, towards identifying osteogenic activities most beneficial in reducing fracture risk.

Methodology

A simplified beam model of the femur was developed in Rhino/Grasshopper. Femoral geometry was used to derive cross-sectional properties (area, second moments of area, and torsion constant) for a hundred slices along the femoral centreline. Different Young's modulus and shear modulus were assigned for cortical and trabecular bone.

Musculoskeletal model derived joint contact and muscle forces for different activities covering a broad range of motion of the hip joint were applied as loads to the model to compute nodal displacements, and internal forces and moments. Outputs include axial force, shear forces, bending moments, and torsion moment distributions, as well as stress and strain distributions.

Preliminary Results

Initial results for idealised load cases demonstrate that the beam model provides comparable results to more complex continuum finite element models of the femur, with around a 1000-fold decrease in computational run times.

Discussion

and Conclusion

Fractures from side falls are associated with a reversal of the bending moment at the femoral neck; therefore, walking alone may not provide sufficient protection. Compared with continuum finite element models, the beam model enables near real-time visualisation for immediate assessment and comparison of activity-specific loading patterns. Stress and strain distribution outputs allow rapid identification of activities inducing elevated osteogenic mechanical stimuli at fracture-prone regions, informing bone adaptation algorithms and serving as an effective communicative tool to guide activity selection for promoting bone health in these regions. By modifying loading and boundary conditions, the model can also be applied for rapid fracture prediction.

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Dominant Versus Non-Dominant Lower-Limb Force-Time Behavior During the Countermovement Jump in Elite Judo Athletes: Discrete and Continuous Analyses.

Dr Felipe Teixeira, Dr Bruno Jotta, MSc Aleksandro Ferreira Gonçalves, PhD Esteban Aedo-Muñoz, André Luiz Fonseca da Silveira e Silva, PhD Bianca Miarka, MSc Pablo Merino-Muñoz

Scheduled presenter: Dr Felipe Teixeira · **Organisation:** Universidade Estacio · **Programme slot:** 09:20-09:22 · **Display:** Poster stand I · **Paper:** 119

DESCRIPTION OF PROPOSED TALK

Judo-specific training may promote inter-limb asymmetries, however, evidence comparing dominant (DOM) and non-dominant (NDOM) lower-limb force-time behavior during the countermovement jump (CMJ) in elite judokas remains limited. This study compared DOM and NDOM limbs using both discrete force-time variables and continuous waveform analysis. Thirty-seven elite Brazilian judo athletes performed bilateral CMJs on dual force plates. Peak force, phase-specific impulse, and mean force were calculated for the yielding, braking, and concentric phases. Force-time waveforms were also analyzed using Statistical Parametric Mapping (SPM). Cross-correlation and coefficient of variation (CV) were used as complementary waveform analyses, and an exploratory asymmetry classification was performed using the asymmetry index (AI). No significant differences were found between DOM and NDOM limbs for any discrete variable ($p > 0.05$), with trivial-to-small effect sizes. Likewise, SPM revealed no significant clusters across the movement cycle. Cross-correlation showed very high waveform similarity between limbs ($r = 0.970 \pm 0.032$). Most athletes were classified as symmetrical, although a greater proportion of asymmetrical athletes was identified for yielding impulse and yielding mean force. These findings indicate a high degree of lower-limb symmetry at the group level in elite judo athletes, while suggesting that the yielding phase may be more sensitive to individual asymmetry patterns.

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Controlled Loading Ergometer for SCI Rowing and Dynamic Trunk Stability Analysis

Miss Tess Manson-Whitton, Mr Thomas Lamb, Mr Thanusan Kannathasan, Mr James Moran, Mr Paolo Resma, Mr Poom Sripratak, Mr Kieran Evans, Mr Max Reddy, Professor Michael Chappell, Dr Neil Evans, Professor Brian Andrews, Dr Panagiotis Tsakonas

Scheduled presenter: Miss Tess Manson-Whitton · **Organisation:** University Of Warwick · **Programme slot:** 09:22-09:24 ·

Display: Poster stand I · **Paper:** 136

DESCRIPTION OF PROPOSED TALK

We plan to present the purpose, basic design and preliminary results for a novel rowing ergometer intended to support both general training and rehabilitation for people with spinal cord injury (SCI).

Current rowing ergometers for individuals with SCI are typically adapted from commercial rowing machines and feature air dampers with velocity-dependent resistance [1]. These systems provide limited control of handle force profiles during the pulling ("drive") phase and do not provide resistance during the "recovery" phase. This study aims to evaluate the feasibility of a new generation of ergometer capable of analysing trunk dynamics and developing new metrics to quantify trunk stability for clinical use and to inform para-rowing decisions.

The ergometer features a bidirectional lever-driven system designed to produce a near-horizontal handle trajectory representative of on-water rowing. The system is coupled to a damper, providing speed-independent, programmable, resistance to enable fully controllable and safe loading throughout both the drive and recovery phases of the rowing cycle. A multi-sensor architecture was implemented, including three-degree-of-freedom force sensing at the handle, centre of pressure and loading measurements in the seat, compressive and tensile forces at the footplate, and inertial measurement units (IMUs) for body segment kinematics. Data are processed in real time and displayed through a fully integrated graphical user interface (GUI), providing force profiles, symmetry metrics, and trunk stability indicators in a clear and clinically meaningful format. Gamified elements are incorporated to encourage engagement [2] and reinforce correct movement patterns during rehabilitation. The sensor system enables quantitative trunk stability assessment using a derived Trunk Stability Score. In addition, the system introduces a perturbation-response based stability assessment, in which controlled random perturbations were used to evaluate the user's ability to maintain trunk stability.

Mechanical usability testing has shown that the design operates smoothly with low inherent resistance (approximately 14.7N) enabling exercises to begin safely within clinically recommended rehabilitation force ranges. Further testing showed high usability, accurate sensor data collection and processing with promising definitions of stability verified using Vicon motion capture software.

The project demonstrates a novel, sensor-rich and programmable rehabilitation ergometer capable of delivering precisely controlled resistance while simultaneously measuring trunk stability during exercise. Our rowing ergometer can evolve simple exercise equipment into a quantitative rehabilitation platform supporting safe, measurable and engaging therapy for individuals recovering from tetraplegic reconstructive arm surgery. Future work will focus on implementing closed-loop resistance control and validating the system through clinical rehabilitation trials.

P08**Musculoskeletal and Sports Biomechanics****Friday 4 September 2026** · 09:10-09:28 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Biomechanical Modeling of Running Footwear for Enhanced Safety and Athletic Performance

Mr Pramod Yadav, Dr Arnab Chanda

Scheduled presenter: Mr Pramod Yadav · **Organisation:** Indian Institute Of Technology Delhi · **Programme slot:** 09:24-09:26 · **Display:** Poster stand I · **Paper:** 169

DESCRIPTION OF PROPOSED TALK

Running is one of the most widely practiced physical activities and a common entity in every sport. However, inadequate conditioning and improper technique frequently lead to injuries such as sprains and fractures. The design of footwear, particularly the insole, midsole, and outsole, plays an important role in enhancing performance and preventing injuries by influencing lower limb biomechanics. While extensive research has been conducted on midsole behavior, few studies have examined how insole and outsole characteristics interact to influence traction, shock absorption, and overall injury risk. Key knowledge gaps include the biomechanics of progressive outsole wear and the combined influence of insole hardness, geometry, and thickness. This study examines the traction performance of both worn and unworn running shoes, assesses the shock absorption provided by insoles during controlled jumping and gait tasks, and identifies design features that can improve running safety and performance. First, the current study evaluated the traction performance of eighteen commonly used running shoes on two different track surfaces under controlled slipping conditions, on common surfaces such as ethylene propylene diene monomer (EPDM) and synthetic material-based track surfaces in wet and dry conditions. The results showed that footwear with modified hexagonal or block-based tread patterns and radial grooves produced the highest ACOF in both tracks and conditions. Additionally, a correlation analysis was conducted between ACOF and the apparent contact area, suggesting that these tread designs exhibit better resistance to synthetic surfaces due to their unique pattern. Further, to assess the impact of insoles on impact attenuation, vertical ground reaction forces (vGRF) were analyzed during jumping tasks. In Drop Jump, the maximum vertical reaction force was measured with and without cushioning (insole), and it was reduced by 12% with the insole. Similarly, the vertical reaction force was significantly reduced by 35% in Counter Movement Jump with an insole compared to without an insole. Furthermore, gait analysis using a pressure-mapping insole further characterized heel-strike loading and mid-stance behavior under both conditions. Future work will incorporate real-time pressure mapping during Quattro Jump tasks to examine dynamic load distribution and cushioning performance. Overall, the findings provide key guidelines on running shoe design and knowledge transfer to the industry. This work aims to support the development of novel footwear solutions that enhance traction, reduce injury risk, and improve performance, with direct applications for the athletic footwear industry.

P09**Orthopaedic, Skin and Soft Tissue****Friday 4 September 2026** · 09:10-09:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Novel Holistic Characterisation of Laser Powder-bed Fusion Implant Surfaces

Mr Jacob Bracegirdle-Morais, Sophie Cox, Luke Carter, Asad Jamal, Steven Avery

Scheduled presenter: Mr Jacob Bracegirdle-Morais · **Organisation:** University Of Birmingham · **Programme slot:** 09:10-09:12 · **Display:** Poster stand J · **Paper:** 35

DESCRIPTION OF PROPOSED TALK

Additive manufacturing, specifically laser and electron beam powder-bed processes, have seen increasing use, and success, in orthopaedic implant production. However, breadth existing standards means that production methods and finishing techniques are not unified across the industry.

Surface adhered particle defects and complex surface topographies are inherent to powder-bed processes. Powder-bed fusion component surfaces are consolidated from metallic feedstock powder in the tens of microns scale, producing complicated surface profiles including partially fused surface features. Previous observations of commercially available acetabular cups highlighted surface adhered particles present on component surfaces. Retained particles are at risk of release prior to, during, and subsequent to implantation; potentially contributing to metallic debris and adverse tissue reactions.

Conventional characterisation techniques fail to capture the complex geometries of PBF components holistically; internal features are inaccessible by line-of-sight methods and top-down views give no indication of the degree of surface particle connectivity, and hence their relative risk of detachment. Herein, micro-computed tomography has been used in conjunction with novel computational analysis to quantify the presence of surface adhered particles on PBF lattices as well as their respective sizes and surface connectivity.

Three laser line energies, known to affect particle adhesion quantity, were used to produce Ti-6Al-4V unit cell lattices. Lattices were CT scanned at 0.9 micron resolution, and sequential morphological erosion was used on datasets to segment surface particles from underlying lattice struts. Further to quantity of particle adhesion consolidation energy density was shown to vary the distributions of particle necking and their relative sizes.

P09**Orthopaedic, Skin and Soft Tissue****Friday 4 September 2026** · 09:10-09:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Efficacy of orthopaedic screw fixations in the tibiofemoral joints: a systematic literature review

Mr Adam Weston, Dr Richard Potter, Dr Rosti Readioff

Scheduled presenter: Mr Adam Weston · **Organisation:** University Of Liverpool · **Programme slot:** 09:12-09:14 · **Display:** Poster stand J · **Paper:** 176

DESCRIPTION OF PROPOSED TALK

Bone fractures and ligament injuries represent a substantial clinical burden, with approximately 249,000 fracture admissions recorded annually in England and around 30,000 anterior cruciate ligament reconstructions performed annually in the UK [1,2]. Orthopaedic fixations (e.g., screws) are widely used to facilitate healing by stabilising fractured bone and by providing fixation of damaged soft connective tissue to bone [3]. However, current fixation approaches may be limited by stress shielding, screw loosening, poor load distribution, pull-out failure and micromotion [4, 5]. These limitations create a research opportunity to improve upon conventional designs.

A systematic literature review was conducted to identify studies that evaluate the efficacy of current screw fixation techniques for treating bone fractures and soft tissue reconstruction in the tibiofemoral joints. Searches were performed across PubMed, Scopus, Web of Science, AMED and CINAHL, using search strings based on predefined inclusion and exclusion terms, leading to an initial list of 807 records. After database searching, duplicates were removed, and publication types were filtered, leaving 580 studies. Subsequently, titles and abstracts were screened for relevance, yielding 226 records; eligibility screening of the full texts followed, resulting in a final selection of 51 studies.

The final 51 papers comprised experimental (e.g., testing on cadaveric and synthetic bones) and computational (e.g., finite element analysis) studies. Commonly tested parameters included screw and thread geometry, screw material, fixation design and screw configuration. Commonly reported outcomes included pull-out strength, insertion torque, cyclic displacement, failure load, construct stiffness and micromotion. Across studies, fixation performance was strongly influenced by bone quality, loading direction and interface conditions. Consistent design-related limitations included stiffness mismatch between fixation and surrounding bone [6], insufficient thread engagement [7,8], sensitivity to screw diameter and orientation [9-11], and material-dependent interface behaviour [12,13]. These factors contributed to stress shielding [6], loosening [7,12,13], pull-out failure [7-13] and micromotion [10,14,15], although variation in test methods sometimes produced contrasting findings.

This review highlights key mechanical failure mechanisms and design limitations associated with conventional screw fixations. The findings suggest that future fixation concepts should be tailored to the specific limitation being addressed. For example, architected fixation designs may be most relevant where failure is driven by poor load distribution, excessive construct stiffness or inadequate interface mechanics, as tuneable architecture could improve stress transfer and bone-implant interaction. However, where limitations are primarily material-related, geometry alone is unlikely to be sufficient, and material selection, surface behaviour and biological integration must also be considered.

P09**Orthopaedic, Skin and Soft Tissue****Friday 4 September 2026** · 09:10-09:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

A Pneumatically Actuated MRI-Compatible Robot for Spinal Therapeutic Injection

Miss Yuxuan Qi, Dr. Aminul Ahemd, Prof. Zion Tse

Scheduled presenter: Miss Yuxuan Qi · **Organisation:** Queen Mary University of London · **Programme slot:** 09:14-09:16 · **Display:** Poster stand J · **Paper:** 187

DESCRIPTION OF PROPOSED TALK

Low back pain is a common clinical condition that can significantly affect patients' quality of life. Spinal injection is a widely used minimally invasive procedure for pain management and diagnosis, where therapeutic agents such as local anaesthetics or corticosteroids are delivered to the target region.[1] Magnetic resonance imaging (MRI) provides high spatial resolution and excellent soft-tissue contrast, which is valuable for spinal diagnosis and image-guided intervention. However, robotic assistance under MRI remains challenging because of the strong magnetic field, radiofrequency pulses, and gradient fields. Conventional electromagnetic actuators are generally unsuitable near the imaging region, while manual needle alignment inside the confined MRI environment still relies heavily on clinical experience. Although several MRI-guided robotic systems have been developed[2], [3], [4], few have specifically addressed the requirements of spinal injection, where a compact patient-mounted solution is still needed.

This research aims to develop a compact MRI-compatible robotic system for lower-back spinal intervention. A pneumatically actuated two-degree-of-freedom robot is proposed to provide controllable pitch and yaw adjustment of the needle guide before insertion. The system is driven by a custom-designed pneumatic stepper motor, which is intended to reduce electromagnetic interference while enabling active motion control in the MRI environment. The design focuses on compactness, low-cost fabrication, and potential integration into radiology workflows.

A preliminary prototype was developed and characterised to evaluate its mechanical feasibility. The current robot has a footprint of 105 mm (W) × 115 mm (L) × 104.3 mm (H), making it suitable for compact patient-mounted use. The mechanism provides a pitch motion range of $\pm 38^\circ$ and a yaw motion range of $\pm 45^\circ$. The yaw motion demonstrated a step size of approximately 2° , indicating the potential for discrete and controllable angular positioning. Based on the geometric motion range, the reachable workspace of the robot was estimated to be approximately 67 mm × 65 mm.

These preliminary results suggest that the proposed pneumatic robotic system can provide a useful range of needle guide adjustment for MRI-guided spinal intervention. The presentation will report the mechanical design, the working principle of the pneumatic stepper motor, and the preliminary workspace analysis of the robot. The potential impact of this research lies in improving the controllability and repeatability of MRI-guided needle placement, reducing dependence on fully manual alignment, and supporting more accessible high-quality image-guided intervention. Future work will focus on improving actuation stability, validating positioning accuracy, and evaluating MRI compatibility.

P09**Orthopaedic, Skin and Soft Tissue****Friday 4 September 2026** · 09:10-09:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts**Talus Biomechanics And Its Forces: A Systematic Review**

Dr Eshelle Hara, Dr. Nick Wragg, Dr Matthew Philpott, Dr Mark Davies, Professor Peter Ogrodnik

Scheduled presenter: Dr Eshelle Hara · **Organisation:** Keele University · **Programme slot:** 09:16-09:18 · **Display:** Poster stand J · **Paper:** 227**DESCRIPTION OF PROPOSED TALK**

The biomechanics of the ankle joint has been extensively researched starting from late 18th century with ankle fractures and since then our understanding of ankle biomechanics has evolved. It is through this that total ankle and talus replacements have been based upon. Since the 1970s the first generation of talus implants were reportedly introduced. Of more recent, 3D printing patient-specific implants, are becoming increasingly performed. In order to understand how talus replacements behave biomechanically, it is vital to understand the biomechanics of the native talus beforehand as well as the forces acting on and through it.

In this systematic review, we aim to present available findings of current literature on the biomechanics of the talus, more specifically the forces that run through it.

We conducted searches through these databases: Web of Science and MEDLINE (PubMed) using the following key words talus, biomechanics and forces. Based on this, 4 general themes were conducted as inclusion criteria in order to meet the aim of the study. They were 1) Architecture of the talus 2) Biomechanics and or properties of taluses (native or implant) and its relation to kinematics 3) Biomechanics surrounding talus replacements 4) forces through and on native talus. Exclusion criteria were 1) conference and or meeting presentations 2) non english 3) video, audio 4) zoology 5) anthropology 6) developmental biology/ evolutionary biology/genetics 7) paediatrics.

Of the 107 references (Web of Science) and 78 from MEDLINE (PubMed), only 46 (43%) and 21 (23%) met the inclusion criteria, correspondingly. Within Web of Science search, 74 out of the 107 were referenced from MEDLINE. 11 (52%) out of the 21 from MEDLINE (PubMed) search outcomes were not seen in Web of Science that were part of the inclusion criteria. Majority of the references were categorised in the second theme.

We can draw from this review that there has been limited focused biomechanical study on the entirety of the talus. Forces onto and surround the talus constitute osseous, and its soft tissue elements and it is difficult to assess it them in combination. Part of this could be due to the multi-articular element of the talus. Understanding of forces will be key to furthering implant design and its clinical applications in longer term outcomes. This review also demonstrated need for clinicians and scientists to broaden references sources outside of their own speciality.

P09**Orthopaedic, Skin and Soft Tissue****Friday 4 September 2026** · 09:10-09:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Omega-3 Regenerative Suncare; the Topical application of Omega-3 for Photoprotective and Restorative Effects from UV DNA Damage.

Miss Millie-Louise Cooper, Dr Elizabeth Ratcliffe, Professor Karen Coopman

Scheduled presenter: Miss Millie-Louise Cooper · **Organisation:** Loughborough University · **Programme slot:** 09:18-09:20 · **Display:** Poster stand J · **Paper:** 23

DESCRIPTION OF PROPOSED TALK

With the increasing incidence and mortality associated with melanoma, it is important that protection measures are in place to reduce the incidence rates of melanoma. This includes protecting the skin from UVB. Introducing omega-3 into diet has shown promising photoprotective characteristics, such as increasing the skin's tolerance to UV DNA Damage (Harauma et al., 2024; Rhodes, 2003). Minimal studies however investigate the topical application of omega-3, particularly marine-based omega-3 compounds derived from fish or more sustainable algal sources, and their potential for added restorative and protective effects. On top of this, there has been no comparative study for using omega-3 before and after UV exposure. This study will investigate the comparative effects of the application of topical marine omega-3 compounds on skin cell models before and after UV exposure, to determine the optimal point of application for regenerative effects against UVB DNA Damage. Melanocytes and keratinocytes will be exposed to UVB radiation, with topical treatments of omega-3 compounds, which will be applied before or after irradiation. Following this, flow cytometry and ELISA assays will be performed to determine key markers of inflammation, DNA damage and repair pathways (specifically, but not limited to p53 expression, number of cyclobutane pyrimidine dimers CPD, and detection of enzyme ERCC1). The detection of these markers will indicate whether topical omega-3 allows for a restorative and regenerative role against UVB skin damage. The potential for photoprotective effects investigated by this novel study aims to expand topical formulation research contributing to increasing the skin's tolerance to UV thereby reducing the risk of melanoma.

O12**AI in Bioengineering II: wearables and clinical deployment****Friday 4 September 2026** · 10:20-11:20 · Space One and Two**Chairs:** Dr Silvia Del Din · Dr Ian Sandall

Injection of pre-trained ImageNet layers to U-Net decoder for biomedical image segmentation

Dr Maciej Szymkowski

Scheduled presenter: Dr Maciej Szymkowski · **Organisation:** Warsaw University of Technology · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 3

DESCRIPTION OF PROPOSED TALK

Artificial Intelligence (AI) and Machine Learning (ML) are essential for modern biomedical solutions, particularly in segmenting Regions of Interest (ROI) from imaging data. However, existing models often struggle to align with specific research scopes because biomedical samples vary significantly based on device quality and data acquisition settings. The primary goal of this research is to accurately segment single Engineered Heart Tissue (EHT) cells from spatial videos. This task is complicated by the presence of non-homogeneous backgrounds that can interfere with standard segmentation techniques. The study evaluated several 2D U-Net architectures to identify the most effective approach for EHT cell isolation. We compared a model trained from scratch against versions utilizing pre-trained backbones, specifically ResNet-50, VGG-16, and InceptionResNetV2. Moreover, we used novel VLMs (like Qwen and InternVL) to compare the segmentation quality with the proposed pipeline. The performance of each configuration was measured using the Dice coefficient and Intersection over Union (IoU) metrics. The experimental comparison revealed high precision across the tested models. The optimal architecture (ImageNet backbone for ResNet-50) reached a Dice coefficient of 0.945705 and an IoU of 0.897424. These metrics indicate a high degree of accuracy in distinguishing the cell boundaries from the complex background. Moreover, traditional model obtained better results than VLMs. The findings demonstrate that while generic models may face alignment issues, specific U-Net backbones can be successfully adapted to handle the nuances of EHT spatial video data. This approach provides a robust solution for automated cell segmentation in specialized biomedical research contexts.

O12**AI in Bioengineering II: wearables and clinical deployment****Friday 4 September 2026** · 10:20-11:20 · Space One and Two**Chairs:** Dr Silvia Del Din · Dr Ian Sandall

Activity Identification Using Wearable IMUs at Multiple Body Locations: A Validation Study Using Machine Learning Approaches

Dr Javad Sarvestan, Mr Erfan Joodi, Dr Behzad Moshiri, Mr Mohammed Mousavi, Dr Hemn Mohammadi, Dr Lisa Alcock, Dr Silvia Del Din

Scheduled presenter: Dr Javad Sarvestan · **Organisation:** Newcastle University · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 17

DESCRIPTION OF PROPOSED TALK

Introduction

Wearable inertial measurement units (IMUs) are increasingly used in healthcare to support remote patient monitoring and assessment of daily activities in real-world environments [1,2,3]. However, despite their growing clinical relevance, it remains unclear if use of a single IMU or IMU combination provides the best balance between accuracy and practicality [4].

Objectives

This study aimed to determine which IMU configuration most accurately detects different daily activities during free-living monitoring.

Methods

Three Axivity AX6 IMUs (Axivity, York, UK; 23 × 32.5 × 8.9 mm; 11 g; 100 Hz; ±8 g; ±2000 dps) were placed on both wrists and the lower back at the L5 level in 51 healthy participants (mean age = 35, gender=42% f). Participants performed 14 daily activities in randomised order in a real-world simulated laboratory setting, while synchronised video recordings were used as the reference for activity labelling. Raw 3-dimensional accelerometer and gyroscope signals were downloaded, synchronized, preprocessed, segmented, and labelled, after which signal features were extracted and reduced before model development. Activity recognition was evaluated using multiple machine learning classifiers, including AdaBoost, Bagging, k-nearest neighbours, Random Forest, support vector machine, Boost, stacking, and a voting-based multi-classifier fusion approach. Models were trained and tested using data from different sensor configurations, including single-IMU, 2-IMU, and 3-IMU combinations, to determine how sensor number and placement influenced classification performance. Model performance was assessed using classification metrics such as accuracy, sensitivity, specificity, and F1-score, and activity detection of 80% or greater accuracy was considered acceptable.

Results

Among all machine learning classifiers, voting-based multi-classifier fusion achieved the highest activity identification accuracy. The 3-IMU setup classified most target activities with approximately 80% or greater accuracy, outperforming reduced-sensor configurations overall. Across single- and dual-IMU setups, the most consistently well-classified activities were bending, sit-to-stand or stand-to-sit, running, washing hands, and lying down, while performance for other activities varied by sensor configuration.

Conclusion

Overall, classification performance was highest with the 3-IMU configuration, indicating that adding more sensors improved activity recognition across a broader range of daily activities. At the same time, different 2-IMU and single-IMU combinations were better suited to particular activity types, showing that sensor choice may be adapted to the intended monitoring purpose.

O12**AI in Bioengineering II: wearables and clinical deployment****Friday 4 September 2026** · 10:20-11:20 · Space One and Two**Chairs:** Dr Silvia Del Din · Dr Ian Sandall

Dynamic Trust Assessment in Wearable-based IoT Healthcare Systems Using Machine Learning

Miss Abir Al-ansari, Dr Kristiaan D'Août, Dr Valerio Selis

Scheduled presenter: Miss Abir Al-ansari · **Organisation:** University of Liverpool · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 25

DESCRIPTION OF PROPOSED TALK

Wearable Internet of Things (IoT) devices are increasingly used in biomedical engineering to support continuous, unobtrusive health monitoring through the collection of physiological and motion data during everyday activities. Their integration into healthcare pathways enables early detection of deviations in physical behaviour and provides clinically meaningful insights into patient health. However, for these systems to be effective, a trustworthy interaction between the individual and the device is essential. This becomes particularly challenging in healthcare settings where deviations from normal behaviour can be caused by underlying medical conditions or incidents. Such variability makes it difficult for the IoT system to assess an individual's trustworthiness when abnormal physical behaviour is present.

Human Activity Recognition (HAR) and user detection offer a structured computational approach to addressing this challenge. By leveraging artificial intelligence and inertial measurements such as an accelerometer, HAR enables the classification of activities and the analysis of movement patterns. Movement characteristics, including gait dynamics, serve as key biomarkers for orthopaedic, neurological, and geriatric assessment. Their unique temporal and spatial patterns not only support accurate activity classification but also contribute to user detection, enhancing the robustness of personalised IoT monitoring systems. As healthcare increasingly adopts remote and continuous monitoring strategies, HAR and user detection become central to interpret sensor-derived behavioural data and directly contributes to trust establishment and determination in IoT systems.

This work presents and evaluates HAR and user detection models as foundational components for trust assessment in IoT healthcare systems. The proposed HAR binary classifier achieved 97.5% accuracy, with precision, recall, and F1 scores exceeding 97%, demonstrating strong reliability in distinguishing between activity states. The user-detection model achieved 82.1% accuracy and recall, 91.6% precision, and an F1 score of 85.7%, indicating its potential for verifying known user. Building on these models, we introduce a methodology for computing dynamic trust scores and define trust levels that reflect the reliability of incoming sensor data. These trust metrics support more robust decision-making by enabling IoT systems to adaptively weight or flag data based on the trust level.

Establishing trust in IoT monitoring pipelines is essential to ensure dependable, continuous assessment of individual health, particularly for older adults and people with chronic or fluctuating conditions. By integrating HAR, user detection, and dynamic trust computation, this work contributes to the development of scalable, clinically aligned digital healthcare solutions capable of supporting long-term monitoring, early intervention, and personalised care.

O12**AI in Bioengineering II: wearables and clinical deployment****Friday 4 September 2026** · 10:20-11:20 · Space One and Two**Chairs:** Dr Silvia Del Din · Dr Ian Sandall

Warning Lead Time ($\Delta\alpha$): Early Detection of Reliability Collapse in Clinical AI Under Distribution Shift

Dr Isaac Acquah, Mr. Michael Asiedu Asare

Scheduled presenter: Dr Isaac Acquah (pre-recorded video) · **Organisation:** Kwame Nkrumah University of Science and Technology · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 31

DESCRIPTION OF PROPOSED TALK

Clinical AI systems deployed in medical imaging operate in non-stationary environments, where distribution shifts arising from changes in patient populations, imaging protocols, and hardware can induce silent performance degradation. In such settings, conventional metrics such as accuracy act as lagging indicators, often detecting failure only after clinically significant errors have occurred, creating a critical safety gap.

We introduce warning lead time ($\Delta\alpha$) as a novel safety metric that quantifies the difference between the critical failure point and the earliest detectable instability signal under controlled distribution shift. Modeling AI systems as stochastic dynamical processes, we investigate early warning signals associated with instability grounded in the theory of critical slowing down, including lag-1 autocorrelation, predictive variance, and entropy skewness.

Using chest X-ray classification across two datasets, PneumoniaMNIST and RSNA Pneumonia Detection Challenge, we systematically vary shift intensity (α) while controlling for task structure and dataset scale, and evaluate multiple architectures (ResNet-18, DenseNet-121, and Vision Transformers). We find that, while model performance degrades as α increases, the detectability of impending failure varies systematically across architectures, with consistent patterns observed across datasets. Convolutional networks exhibit gradual degradation with measurable warning lead time, whereas transformer-based models can undergo abrupt collapse, with $\Delta\alpha$ collapsing to near zero. This behavior persists across multiple signals, suggesting that early warning signals are not universally reliable, but contingent on underlying model dynamics.

Building on these findings, we outline a Safety Shell framework that integrates instability detection, intervention policies, and uncertainty quantification to enable proactive mitigation before clinical failure. This work reframes the evaluation of clinical AI systems from static performance assessment toward dynamic stability monitoring, with implications for safer deployment, architecture selection, and regulatory oversight in medical imaging systems.

012**AI in Bioengineering II: wearables and clinical deployment****Friday 4 September 2026** · 10:20-11:20 · Space One and Two**Chairs:** Dr Silvia Del Din · Dr Ian Sandall

Optimising Prostate Cancer Diagnosis with AI-Assisted Surface-Based Ultrasound-Derived Prostate-Specific Antigen Density

Mr Rory Bennett, Professor Tristan Barrett, Professor Vincent Gnanapragasam, Professor Zion Tse

Scheduled presenter: Mr Rory Bennett · **Organisation:** Queen Mary University of London · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 123

DESCRIPTION OF PROPOSED TALK

Considering the high incidence and mortality rates of prostate cancer [1], one might wonder why screening is currently not recommended within the NHS. Associated costs, low specificity, and patient distress make current detection methods unsuitable for screening purposes. Surface-based ultrasound (SUS)-derived prostate-specific antigen density (PSAD) presents itself as a potential risk stratification metric that fits neatly into the current diagnostic workup for prostate cancer.

SUS-derived PSAD is not subject to the same limitations as current detection methods and is generally considered accurate enough when compared to more contemporary metrics [2]. Furthermore, current state-of-the-art object detection frameworks are able to track the prostate in SUS images at real-time speeds [3]. The next step, following real-time tracking of the prostate in SUS images, involves estimating prostate volume from SUS scans of the prostate.

The approach followed in this work used the ellipsoidal assumption of the prostate, requiring three dimensions, or six endpoints, across two orthogonal images taken at the centre of the prostate: the right-left (RL) and anterior-posterior (AP) dimensions on the transverse image, and the superior-inferior (SI) dimension on the sagittal image. To help estimate these dimensions, various deep learning models were considered: two object detection models, YOLO [4] and RetinaNet [5]; a segmentation network, nnUNet [6]; and a key point localisation network [7]. Object detection-to-segmentation pipelines were also used to further improve the segmentation results, where the outputs of the object detection models were used as localisation inputs to the segmentation model.

Detection boxes on the transverse images were converted into the RL and AP dimensions using the box dimensions, while the hypotenuse of the sagittal detection box was used as the SI dimension with a correction factor. Segmentation boundaries were converted into dimensions in a similar manner, with RL and AP taken as the largest horizontal and vertical dimensions of the segmentation result, respectively, and the SI dimension calculated using the most top-left and most bottom-right points of the segmentation boundary.

Model performance varied across individual dimensions, with the segmentation models returning the most accurate prostate volume estimates. When using the model-derived volumes to calculate PSAD, depending on the threshold used, 100% agreement with the clinical standard of MRI-derived PSAD was achieved for some of the segmentation models. These preliminary results, carried out on a clinical prospective dataset of 19 patients, are incredibly promising for the future development of SUS-derived PSAD triage workflows aimed at reducing unnecessary biopsy referrals.

012**AI in Bioengineering II: wearables and clinical deployment****Friday 4 September 2026** · 10:20-11:20 · Space One and Two**Chairs:** Dr Silvia Del Din · Dr Ian Sandall

Remote monitoring of cardiovascular trends in pregnancy using PPG waveforms.

Ifeanyu Nzegbuna, Kathryn Hunt, Mark White, David O'Connor, Ioannis Polydoros, Dale Kernot, Hari Arora, Rebecca Reynolds, Prof Raoul Van Loon

Scheduled presenter: Prof Raoul Van Loon · **Organisation:** Swansea University · **Programme slot:** 11:10-11:20 · **Order:** 6 · **Paper:** 143

DESCRIPTION OF PROPOSED TALK

Obtaining basic cardiovascular metrics such as heart rate from wearable devices is now commonplace, however developing low-cost technologies that enable home-based health monitoring for pregnant women-particularly to prevent high-risk outcomes-remains challenging. Access to physiologically meaningful, non-hospital-based information that can support timely clinical decision-making is essential for reducing global maternal and infant morbidity and mortality.

The primary objective of this study is the quantification of key cardiovascular changes across gestation through a wearable-based remote monitoring solution.

The study explores longitudinal trends in physiological attributes (implicit biomarkers) derived from wrist-captured, green-wavelength Photoplethysmogram (PPG) in a cohort of 60 pregnant women, 14 of whom experienced pregnancy-related complications. Multiple weeks of raw PPG recordings were processed, filtered, and screened for motion artefacts, yielding an average of 30-50 hours of moderate to high-quality waveforms per participant. From these signals, three PPG-derived indices were computed - namely Stiffness Index (SI), Augmentation Index (AI), and Reflection Index (RI) -which are respectively associated with arterial stiffness, wave reflection and vascular tone, and peripheral resistance from arterioles.

Across gestation, women diagnosed with Fetal Growth Restriction (FGR), Gestational Hypertension (GH), Gestation-Induced Postnatal Hypertension (GIPH), and Pre-eclampsia (PE) exhibited dominant median SI values occurring within certain ranges of AI and RI:

- FGR SI $\approx$ 7.4 m/s, AI 11-20%, RI 81-90%
- GH SI $\approx$ 6.74 m/s, AI 21-50%, RI 51-80%
- GIPH SI $\approx$ 6.74 m/s, AI 31-40%, RI 61-70%
- PE SI $\approx$ 6.59 m/s, AI 11-20%, RI 81-90%

Binary comparisons of each group of pregnancy complications with corresponding cohort of those who had uncomplicated delivery showed small to large effect sizes (Cliff's delta) - relatively distinct group-level differences across SI, AI, and RI. Together, these patterns highlight the potential of PPG-derived SI, AI, and RI to support gestational vascular monitoring by reflecting physiological signatures associated with clinically diagnosed complications.

O13**Computational Modelling II: patient-specific simulation****Friday 4 September 2026** · 10:20-11:20 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Porous medium approach for modelling lung ventilation and drug delivery

Dr Svetlana Aleksandrova, Dr Sarah Diver, Dr Humberto Medina, Dylan Spokes, Zack Dingwall, Yuma Hamano, Hashim Farhad, Prof Stephen Benjamin

Scheduled presenter: Dr Svetlana Aleksandrova · **Organisation:** University of Leicester · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 73

DESCRIPTION OF PROPOSED TALK

Regional variation in air flow and particle transport in the human lung may influence clinical outcomes in pulmonary diseases. Differential deposition of inhaled particles such as pollutants, microbes, allergens and therapeutic aerosols is dependent on airway structure, breathing pattern and particle properties. Computational models provide non-invasive insights that can support better mechanistic understanding of disease and precision medicine approaches to treatment.

A major challenge is that modelling the full airway tree is computationally expensive. As a result, many studies use truncated geometries that include only the larger conducting airways. Although this enables detailed prediction of flow in the central airways, it neglects the effects of the distal airways and alveolar region. Accounting for these distal regions is essential for determining ventilation distribution and particle deposition, particularly in diseased lungs. One-dimensional (including volume-filling) models provide a more efficient way to represent the distal airway tree, but they are difficult to couple directly with detailed three-dimensional models of the anatomically complex upper and central airways.

In this work, we present a porous-medium-based modelling framework that can help bridge this gap by resolving large airways in detail, while representing the influence of the smaller airways and alveolar region in a computationally practical way. It couples explicitly resolved large conducting airways with a continuum representation of the smaller airways and alveoli. The model reproduces realistic ventilation behaviour and flow patterns, and provides a framework for assessing particle transport and deposition within the explicitly resolved conducting airways while accounting for the influence of the unresolved distal lung.

The framework provides a route towards more physiologically representative and patient-specific respiratory simulations that can be adapted to different patient or disease conditions. Regional differences in lung properties, disease-related changes in airway resistance, and dynamic effects such as lung expansion, contraction and hysteresis can be incorporated within the porous medium description. By linking detailed airway CFD with whole-lung behaviour, this approach offers a practical platform for biomedical applications including assessment of airborne particle exposure, investigation of pollutant and allergen transport, ventilation assessment, and inhaled therapy design.

013**Computational Modelling II: patient-specific simulation****Friday 4 September 2026** · 10:20-11:20 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Validation of a Novel Axial Length MATLAB Digital Optimisation Tool within Cataract Patients

Mr Jay Davies, Dr Ahmed Abass, Dr Hannah Levis

Scheduled presenter: Mr Jay Davies · **Organisation:** University of Liverpool · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 51

DESCRIPTION OF PROPOSED TALK

Background

/Aim: Biometers used to obtain measurements for axial length (AL), a key measurement in intraocular lens power calculations, are usually costly and heavy with varying degrees of accuracy. This study aims to assess the clinical feasibility and accuracy of a novel non-invasive method of ocular biometry undertaken via light ray tracing methods, in comparison to the Aladdin biometer (Topcon, Tokyo, Japan).

Methods

The right eyes of forty-two patients with cataracts (72% female) with a mean age of 71 ± 12 were successfully assessed using both devices. Measurements of distance between the patient and fixation target were taken for the novel device, and AL measurements were taken with the Aladdin, performed in a randomised order. Two fixation targets were used for the blind spot test included within the MATLAB Digital Optimisation Tool (MDOT), with 28 for target 1 and 14 for target 2. Light ray tracing simulations were performed within MATLAB to ascertain the AL for each subject. Mean differences $\pm$ standard deviations in AL were subsequently compared between the MDOT and Aladdin biometer.

Results

Mean differences in AL measurements between the MDOT and Aladdin biometer were 1.11

± 1.57 mm for target 1 and -0.15

± 0.68 mm for target 2. Statistically significant differences in AL were found between devices for target 1 ($p < 0.001$) but not target 2 ($p = 0.420$). Target 1 produced an intraclass correlation coefficient of 0.03, with target 2 significantly closer at 0.94.

Conclusions

The potential for a non-invasive AL calculation method using light ray tracing is demonstrated here, although further development and study is required in order to improve individual accuracy of measurements and tailoring of idiopathic ocular geometry.

O13**Computational Modelling II: patient-specific simulation****Friday 4 September 2026** · 10:20-11:20 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Agent-Based Multiscale Modelling of Asthma Predicts Accelerated Remodelling in Small Airways Relative to Large Airways

Mr Charles Laundon, Mr Mahesh K. Ola, Dr Himanshu Kaul

Scheduled presenter: Mr Charles Laundon · **Organisation:** University of Leicester · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 112

DESCRIPTION OF PROPOSED TALK

Introduction

The prevalence of asthma now stands at ~300 million people around the globe [1] and creates an economic burden amounting to more than \$5 billion per year in the US alone. Asthma results in structural changes in airway wall in a process called remodelling, which increases airway wall stiffness making airways less distensible and more resistant to deformation during breathing or bronchoconstriction. Studies have shown that this contributes to fixed airflow limitation. Standard spirometry testing, however, is currently unable to detect any pathological changes in the "silent zone" airways until ~75% damage has already occurred in these airways [2]. Despite this significance, the dynamics of airway remodelling in the silent zone remain elusive. This is critical because detecting Small Airway Dysfunction (SAD) before structural changes become untreatable can significantly improve patient outcomes.

Methods

To understand the dynamics of remodelling in the silent zone, we used the agent-based virtual asthma patient [3] model to simulate cell remodelling in 27 Horsfield airway orders. The model works by simulating T2-high asthma pathophysiology. Simulations captured time scale of over 6 months of physical time. Simulations were run five times to quantify the impact of stochastic features on variance in model output. We tested the hypothesis that smaller airways remodel faster than larger airways. Simulation output included change in muscle agents (i.e. airway smooth muscle and myofibroblast agents), fibroblast agents, and epithelial integrity.

Results

& Discussion

Progression of average muscle mass per square millimeter over time was quantified to resemble the cell recruitment and myofibroblast migration, as set by Saunders et al. [4]. Our results revealed that the rate of muscle mass increase is faster in smaller airways. We also observed faster fibroblast growth in smaller vs larger airways. Importantly, we observed modest difference between smaller vs larger airways in terms of change in epithelial integrity. These findings demonstrate that the remodelling rate in the silent zone is faster than larger airways, confirming our hypothesis. The results highlight the spatial heterogeneity of airway remodelling in asthma and help explain why the smallest airways are the key contributors to asthma.

Conclusion

This model represents a major step forward in systematically investigating how dimensional aspects influence airway remodelling. In doing so, it will enable us to design and evaluate interventions that drive proportional impact on smaller airways.

013**Computational Modelling II: patient-specific simulation****Friday 4 September 2026** · 10:20-11:20 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Characterising real-world gait trajectories following morning medication intake in Parkinson's disease

Dr Aron Syversen, Miss Emma Packer, Mr Philip Brown, Professor Alison J Yarnall, Professor Lynn Rochester, Dr Lisa Alcock, Dr Silvia Del Din

Scheduled presenter: Dr Aron Syversen · **Organisation:** Newcastle University · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 153

DESCRIPTION OF PROPOSED TALK

Introduction

People with Parkinson's (PwP) are typically prescribed dopaminergic medication (e.g. levodopa) to improve motor symptoms and gait impairment. Research has shown that in controlled settings, there are improvements in gait post-medication intake¹. Wearable sensors can also characterise gait, specifically Digital Mobility Outcomes (DMOs), in real-world environments. However, the extent to which medication effects on gait can be characterised in this setting remains unclear. Aim: To assess whether gait trajectories following morning medication can be modelled from real-world gait data in PwP.

Method

Fifty-five PwP underwent 7-day monitoring with an Axivity AX6 accelerometer worn on the lower-back and a smartwatch². Validated algorithms extracted micro DMOs (including mean step velocity, length and time alongside their variability and asymmetry) and macro DMOs (including total steps, walk time and number of walking bouts)³. Medication intake events were self-reported via a watch that delivered reminders. DMOs were extracted at 5-minute intervals, and gait windows from 30-minutes pre-dose to 120-minutes post-dose were anchored to a medication event. A polynomial mixed-effects model was fitted per feature with fixed effects for linear and quadratic post-dose time terms, pre-dose baseline gait, alongside a random intercept and slope per participant. Benjamini-Hochberg correction was applied. Where significant, AIC confirmed the improved fit and a time-to-peak effect was derived as the vertex of the fitted quadratic.

Result

Forty-four participants were included in analysis (68.2% male, age=64.3±9.6, MDS UPDRS Total=51.2±16.5, years-since-diagnosis=4.0±2.8 years), yielding 409 morning dose-events. Significant linear increases were identified in total steps (p=0.002), total walk time (p=0.002), and mean step length (p=0.037) per 5-minute interval over 120 minutes. Step time and step velocity variability showed significant quadratic time effects (p=0.0003 and p=0.027 respectively), resulting in a U-shaped trajectory confirmed by AIC, with group-level time-to-minimums of 38 and 23 minutes.

Discussion

Findings suggest that changes in real-world gait can be modelled post-morning medication intake. Macro DMOs and step length showed sustained linear improvement over 120 minutes, suggesting that full medication response extends beyond the observation window. For step variability features, a U-shaped response with a delayed rise indicates a different trajectory than expected from controlled laboratory settings. In real-world monitoring, increased variability may be context-dependent reflecting participants' ability to adapt gait to their environment and daily activities, however, interpretation is evolving as it captures a wider range of influences beyond controlled settings⁴. These findings support the feasibility of continuous post-dose gait characterisation with implications for remote monitoring in PwP.

013**Computational Modelling II: patient-specific simulation****Friday 4 September 2026** · 10:20-11:20 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Topological and Haemodynamic Analysis of Synthetic Retinal Microvascular Networks

Dr Remi Hernandez, Dr Wahbi El-Bouri

Scheduled presenter: Dr Remi Hernandez · **Organisation:** University of Liverpool · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 171

DESCRIPTION OF PROPOSED TALK

The TARGET project aims at integrating digital twins (DTs) into all pillars of the atrial fibrillation-related stroke pathway for dynamic risk stratification and personalised care[1]. Cerebrovascular DTs can support stroke aetiology classification and clinical decision-making, but are difficult to implement pre-stroke due to imaging requirements. These modalities also lack microcirculatory information linked with stroke risk and severity[2].

Retinal microvessels are accessible, before any hospitalisation, through non-invasive imaging modalities such as optical coherence tomography angiography (OCTA). OCTA can differentiate stroke subtypes and predict stroke incidence from retinal microvascular features[3]. Understanding links between microvascular structure, haemodynamics and stroke risk may improve DT-assisted stroke management.

We created realistic, retinal vascular networks. As the retina is a terminal organ, networks had a single inlet and outlet: the central retinal artery (CRA) and vein (CRV). Arterial and venous trees are generated using procedural growth algorithms[4]. Trees were joined by Voronoi-based capillary beds. Three parallel layers of capillaries are modelled, represent the three retinal capillary plexuses, connected through penetrating arterioles and venules[5]. Capillary densities in the superficial (SVP), intermediate (ICP) and deep capillary plexus (DCP) were randomly sampled and blood flow was modelled using a Poiseuille flow model.

We investigated how vascular morphology and topology affect functional metrics (i.e., blood flow and oxygenation metrics). Morphological, topological, and haemodynamic metrics were computed, including vascular density and length density, network connectivity, blood flow, and transit time measures.

We generated a virtual population of 500 vascular networks. Patient specific blood pressure values at the CRA and CRV were used as boundary conditions to the flow model. The value of the Voronoi diagram seed spacing allowed us to control vascular density. The resulting macular vascular densities, namely 30-50% for the SVP and 15-22% for the ICP and DCP, as well as vessel length density ($0.016\text{--}0.060\mu\text{m}/\mu\text{m}^2$) were in line with empirical OCTA measurements[5,6].

Preliminary analyses suggested associations of transit times, residency times and capillary velocity distribution with vertex degree distribution, loop density, meshedness coefficient and redundancy index. The CRA radius was also inversely associated with higher mean transit time but did not affect transit time heterogeneity or capillary residence times.

In future work, the current model will be coupled with a three-dimensional oxygen model to simulate tissue perfusion. Our group has previously demonstrated the possibility of integrating vascular backbones extracted from clinical images into a similar framework[7]. The framework could support retinal DTs for stroke risk stratification.

O13**Computational Modelling II: patient-specific simulation****Friday 4 September 2026** · 10:20-11:20 · Space Four**Chairs:** Professor Amy Zavatsky · Dr Rosti Readioff

Mobgap v.20: a state-of-the-art python package for estimation of digital mobility outcomes from a single wearable device

Dr Cameron Kirk, Dr Arne Kuederle, Mr Paolo Tasca, Dr Metin Bicer, Dr Dimitrios Megaritis, Dr Eran Gazit, Dr Anisora Ionescu, Dr Chloe Hinchliffe, Dr Alex Sithi, Dr Anika Mucke, Mr Zamal Babar, Professor Ioannis Vogiatzis, Professor Bjorn Eskofier, Professor Claudia Mazza, Professor Andrea Cereatti, Dr Arne Mueller, Dr Daniel Rooks, Professor Brian Caufield, Professor Lynn Rochester, Dr Silvia Del Din

Scheduled presenter: Dr Cameron Kirk · **Organisation:** Newcastle University · **Programme slot:** 11:10-11:20 · **Order:** 6 · **Paper:** 34

DESCRIPTION OF PROPOSED TALK

Introduction

Mobility assessment in clinical trials remains largely reliant on self-report and brief in-clinic tests, capturing capacity rather than real-world performance and limiting ecological validity. Wearable technologies enable continuous, objective measurement of mobility through digital mobility outcomes (DMOs), with walking speed emerging as a key clinically meaningful metric. The Mobilise-D project developed a validated multi-stage pipeline for DMO estimation across diverse clinical populations [1-3]; however, its partial reliance on proprietary software constrained accessibility and reproducibility. To address this, the pipeline was re-implemented as the open-source Python package mobgap available on GitHub [4, 5]. This study presents a reproducible revalidation using the Mobilise-D Technical Validation Study, establishing a transparent benchmark for future development.

Methods

Validation used the publicly available Mobilise-D Technical Validation Study dataset [6], comprising participants with five chronic conditions and healthy controls across Europe. Participants completed 2.5-hour real-world assessments wearing a lower-back McRoberts MM+ (100 Hz), with a multi-sensor reference system (INDIP) as ground truth [7]. Mobgap is a modular Python pipeline for deriving DMOs from inertial data, including gait sequence detection, initial contact detection, stride length, cadence, and walking speed. Units, coordinate systems, and data structures are standardised to ensure reproducibility [8]. Validation performance was evaluated at both block and full-pipeline levels using cohort-level error metrics (mean and 95% confidence intervals) during real-world assessment.

Results

Gait sequence detection achieved F1 scores of 0.72-0.85, and initial contact detection reached 0.84-0.94 with timing errors of 0.05-0.07 s. Cadence estimation showed absolute errors of 4.9-10.0 steps/min (ICC >0.7 in most cohorts), while stride length was the most challenging outcome (0.13-0.18 m error; ICCs generally <0.7). Overall pipeline performance was comparable to or improved upon the original implementation[1, 3], particularly for stride length. For full pipeline validation (n=1984 walking bouts), walking speed was estimated with 0.10 m/s absolute error, 11.8% relative error, and good agreement (ICC=0.81), with slight underestimation (-0.04 m/s). Cohort-level errors ranged from 0.08-0.12 m/s, with ICCs from 0.53 to 0.93, demonstrating consistent performance across populations and improved walking bout detection.

Conclusions

Mobgap 2.0 provides an open-source, reproducible implementation of the Mobilise-D pipeline for end-to-end DMO estimation from lower-back wearable inertial device. Its modular and extensible design enables standardised benchmarking and integration of new algorithms, supporting transparent comparison and accelerating methodological development. Mobgap establishes a robust baseline for scalable, real-world mobility assessment in clinical and research settings.

O14**Skin and Soft-Tissue Mechanics****Friday 4 September 2026** · 10:20-11:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Adaptable Mechanically Active Dressings for Reduced Scarring

Mr Edward Rees, Mr Michael Crichton, Ms Marta Vallejo

Scheduled presenter: Mr Edward Rees · **Organisation:** Heriot-watt University · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 54

DESCRIPTION OF PROPOSED TALK

Wound care places a substantial burden on patients and healthcare systems, with outcomes strongly influenced by the mechanical environment during healing [1]. Elevated tensile forces, including those induced during wound closure with stitches, promote fibrotic skin repair, increasing the risk of scarring and wound reopening [2]. Conventional approaches such as suturing provide static mechanical support but cannot adapt as tissue properties evolve during healing. Furthermore, stitches penetrate fragile tissue and introduce localised stress concentrations, contributing to uneven loading and increased risk of infection [3]. Offloading wound tension, in contrast, has been shown to reduce disorganised collagen deposition and improve healing quality by modulating mechanically driven cellular responses [4]. Mechanically active dressings (MADs) - wound dressings capable of controlled contraction - offer a route to dynamic, spatially distributed control of wound tension; however, existing systems lack true adaptability and controllability. This work presents the development of an adaptive pneumatic MAD designed to modulate wound tension in a controlled and tunable manner, enabling both therapeutic application and investigation of time-dependent mechanical loading strategies.

Our device consists of embedded pneumatic channels within a compliant silicone elastomer (Ecoflex), combined with anisotropic fibre reinforcement to direct deformation and achieve predominantly unidirectional contraction across an incisional wound. We fabricate these devices using 3D-printed moulds and laser-cut fibrous reinforcements through a soft-lithography-inspired casting process. A compact Arduino-controlled pneumatic system, integrating a pump, solenoid valves, and pressure sensing, enables programmable inflation-deflation cycles. Mechanical performance was characterised through tensile force measurements and optical tracking of surface deformation. Ex vivo validation was conducted using porcine skin samples with a 4 cm incision, mounted under physiological pre-strain (~15%) before MAD application. Actuation of our MAD produced repeatable, pressure-dependent offloading of applied strain, with consistent wound-edge approximation and no observed adhesive failure. Surface strain measurements showed how loading was redistributed across the wound model during actuation, enabling assessment of both spatial uniformity and time-dependent mechanical response.

These findings demonstrate that our adaptive pneumatic MAD can achieve controllable and repeatable tension modulation in biologically relevant tissue models. Ongoing work focuses on expanding multi-axial control to support patient-specific wound geometries and on progressing to more complex tissue models prior to in vivo evaluation. By enabling non-invasive, adjustable wound tension modulation, our approach has the potential to reduce scarring and wound reopening, supporting improved healing outcomes for patients with wounds at risk of excessive mechanical loading.

O14**Skin and Soft-Tissue Mechanics****Friday 4 September 2026** · 10:20-11:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Evaluating the Validity of Animal Models in Representing Human Colon and Colorectal Cancer Tissue Mechanics

Dr Ciara Durcan, Dr Paul Hawthorne, Dr Vidya Rajasekaran, Dr Zoe Sudderick, Dr Emily Miedzybrodzka, Dr James Glover, Dr Kathryn Kirkwood, Mr Hugh Paterson, Prof Susan Farrington, Prof Emeritus Robert Reuben, Dr William MacPherson, Prof Duncan Hand, Prof Yuhang Chen

Scheduled presenter: Dr Ciara Durcan · **Organisation:** Heriot-Watt University · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 84

DESCRIPTION OF PROPOSED TALK

As a mechanical organ, the material properties of the colon are integral to its function. Experimental investigation of its tissue mechanics improves understanding of how pathophysiology affects large intestine function, and provides data to inform and validate constitutive material models used in computational simulations. These models are increasingly important in the design of medical devices such as colonic stents and novel colonoscopy systems. However, while human tissue is most relevant for such applications, experimental studies are often conducted using animal models due to accessibility constraints, with limited understanding of how well these replicate human mechanical behaviour.

This work aims to assess the suitability of commonly used animal models for representing human colon mechanics, while also establishing a detailed, layer-dependent characterisation of colonic tissue behaviour. A series of ex vivo tensile experiments was conducted on human and porcine colon to investigate the effects of region (ascending and descending), layer (intact wall, mucosa-submucosa, and muscularis propria), and loading direction (longitudinal, circumferential, and 45°). In addition, region-dependent behaviour of murine colon was explored in the longitudinal direction. This enables direct comparison of mechanical data across human, porcine, and murine tissue. Histological analysis, including staining to identify collagen, elastin, and smooth muscle, was performed to investigate the structural origins of the observed mechanical behaviour.

The results highlight clear interspecies differences in tensile properties, with variations dependent on region, layer, and loading direction. These findings indicate that commonly used animal models do not fully replicate the mechanical behaviour of human colon, particularly when layer-specific effects are considered.

In parallel, the mechanical behaviour of colorectal cancer (CRC) was investigated to explore its potential diagnostic and mechanobiological relevance. Indentation experiments were performed on human CRC and matched normal colon tissue, and compared with microindentation experiments conducted on a murine CRC model incorporating both WildType and Shroom2Knockout genotypes. As Shroom2Knockout represents a genotype associated with increased CRC susceptibility, differences in mechanical behaviour may reflect underlying mechanobiological influences. Increased stiffness was observed in tumour tissue relative to normal colon. Histological analysis and confocal imaging were used to investigate the structural basis of these differences.

Overall, this work provides insight into the suitability and limitations of animal models for human colon mechanics and demonstrates how changes in tissue composition influence mechanical behaviour in both healthy and diseased states. These findings support the development of improved computational models, medical device design, and potential mechanical markers for CRC diagnosis and surgical guidance.

O14**Skin and Soft-Tissue Mechanics****Friday 4 September 2026** · 10:20-11:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Finite element and neuroimaging analyses of cranial decompression procedures in traumatic brain injury

Dr Charlotte Brass, Dr Chirag Jain, Dr Bhagavatula Indira Devi, Dr Marta M Correia, Prof David K Menon, Dr Angelos Kolias, Dr Virginia F J Newcombe, Prof Michael P F Sutcliffe

Scheduled presenter: Dr Charlotte Brass · **Organisation:** University Of Cambridge · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 146

DESCRIPTION OF PROPOSED TALK

Problem

Cranial decompression procedures open a large portion of the skull to relieve elevated intracranial pressure in severe cases of traumatic brain injury (TBI). Clinically, the influence of the biomechanical differences between the standard decompressive craniectomy (DC) procedure, and novel hinge craniotomy (HC) and expansile craniotomy (EC) procedures remain largely unknown. Following decompression, some patients experience brain expansion (herniation) through the skull opening; there is no formalised timeline of herniation evolution in the medical literature, and it is unknown whether this herniation is linked to brain tissue damage.

Aim

This study aims to investigate the biomechanics of the three types of surgical decompression using finite element (FE) analysis; evaluate temporal herniation evolution using structural magnetic resonance imaging (MRI); infer the clinical effect of herniation on white matter tissue integrity at regions of interest (ROI) using diffusion MRI.

Methods

Three, two-step FE models were created from rapid CT scan including ventricle and membrane geometry. The first step recreated the conditions under which decompression surgery is performed; the second step opened the skull to study the biomechanical effect of herniation.

To link maximum principal strain (MPS) to estimations of tissue integrity loss, herniation area was calculated from structural MRI in a cohort of 20 hemi-craniectomy patients and used in a diffusion MRI analysis to test the hypothesis that increased herniation area was correlated with changes in diffusion MRI parameters (fractional anisotropy (FA), mean diffusivity (MD)) indicative of white matter integrity loss at strain concentration sites.

Results

FE: DC allows higher maximum herniation and correspondingly higher average MPS at an anterior ROI than HC, which in turn exceeds EC. However, the craniotomy procedures (HC, EC) have additional strain concentrations around all flap edges that exceed in vitro thresholds for damage.

MRI: Significant differences in herniation area were observed between the 0-2 day and 8-42 day timepoints ($p < 0.05$), and between the 8-42 day and 42 day+ timepoints ($p < 0.01$). Increase in herniation area was found to predict additional FA decrease in the anterior ROI ($p < 0.014$).

Impact

We present the first formalised timeline of herniation, and a biologically plausible link between herniation and estimations of white matter integrity loss at sites of herniation-induced mechanical strain. The neuroimaging analysis provides in vivo validation of the strain concentrations predicted by finite element modelling; MPS may be used as a biomarker to guide surgical decision-making and ultimately improve patient outcome.

O14**Skin and Soft-Tissue Mechanics****Friday 4 September 2026** · 10:20-11:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Towards Inclusive CPAP Mask Design: Assessing Fit and Pressure Across Facial Profiles

Miss Sahar Sattar, Dr Will Newton, Dr Jennifer Thompson

Scheduled presenter: Miss Sahar Sattar · **Organisation:** Swansea University · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 116

DESCRIPTION OF PROPOSED TALK

Obstructive sleep apnea (OSA) is a serious sleep-related breathing disorder, causing significant negative effects on cardiovascular health and quality of life [1]. Continuous positive airway pressure (CPAP) therapy is a non-invasive ventilation treatment method for OSA, where respiratory airways are forced open, causing a reduction in airway blockage and providing an increase in blood oxygen saturation [2]. Despite the high treatment efficiency, long-term adherence to CPAP remains suboptimal due to patient discomfort, poor mask fit, air leakage and pressure-related skin injury. Current mask fit evaluation methods rely heavily on rigid, simplified headforms and patient feedback, limiting the ability to objectively quantify mask-to-face interactions. Additionally, there is limited research into how soft tissue mechanics affect mask fit.

This research evaluates the fit and pressure of standard oronasal CPAP masks through the development of high-fidelity head models. Quantification of superficial and deep facial pressures is achieved through a novel, load-controlled experimental approach.

A two-part, anatomically representative head model consisting of a soft silicone facial surface with embedded pressure sensors and a rigid head structure provides a robust testing platform for mask-to-face pressure analysis that replicates soft tissue facial mechanical behaviour. A commercially available CPAP mask is attached to the head model. Strap tension is incrementally applied in a repeatable manner using a universal tensile machine. This allows direct measurement of the applied tension and resulting pressure distribution across clinically relevant facial regions.

This approach provides significant advancement over existing evaluation techniques by allowing for reproducible and quantitative assessment of mask fit under controlled mechanical conditions. Initial results positively portray the experimental ability to identify localised high-pressure regions associated with discomfort and potential tissue damage.

A key innovation of this work is the use of simplified, parametric facial geometries as a baseline for controlled analysis, where further development includes introducing a range of anatomically representative facial profiles of different ethnic backgrounds. This addresses a critical limitation in current design practice, where datasets often fail to capture the diversity of facial morphology across different populations. By enabling systematic investigation of mask performance across varied geometries, the platform supports the development of more inclusive and better-fitting designs.

The research combines principles from biomechanics, materials engineering and medical design, with potential collaboration with clinical and industrial partners in respiratory care.

This work contributes a scalable and reproducible framework for CPAP mask evaluation with potential impact on inclusive design, patient comfort and improved treatment adherence.

O14**Skin and Soft-Tissue Mechanics****Friday 4 September 2026** · 10:20-11:20 · Space Five**Chairs:** Professor Michael Crichton · Dr Anders Aufderhorst-Roberts

Ex vivo experimental investigations and modelling of visco-hyperelastic behaviour of the human facial tissues

Mr Eyad Awad

Scheduled presenter: Mr Eyad Awad · **Organisation:** Grenoble Alpes University · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 129

DESCRIPTION OF PROPOSED TALK

Human facial muscles are essential for mastication, speech, and emotional expression, and their complex biomechanical behaviour plays a critical role in surgical planning, soft tissue reconstruction, and computational simulation of facial dynamics.

Despite extensive studies on skeletal muscle mechanics, limited experimental data are available for facial muscles, particularly regarding strain-rate sensitivity, rupture behaviour, and the influence of tissue preservation methods. Facial muscles possess distinct structural and functional characteristics compared with other skeletal muscles, including differences in fibre arrangement and geometry, making it inappropriate to directly apply constitutive models developed for other muscle tissues.

This study therefore investigates the visco-hyperelastic and failure behaviour of human facial muscles under varying strain rates and preservation conditions. Human facial muscle samples, including the masseter, zygomaticus major, zygomaticus minor, orbicularis oris, and buccinator, were obtained from cadaveric donors in both fresh and formalin-fixed states. Following dissection and preparation into standardised geometries, uniaxial tensile tests were performed using cyclic loading protocols with progressively increasing stretch levels informed by preliminary rupture experiments.

Mechanical testing was conducted at strain rates of 0.001 s^{-1} and 0.01 s^{-1} , and force-displacement data were converted into nominal stress-stretch relationships to evaluate stiffness, hysteresis, extensibility, and rupture characteristics. All facial muscle samples demonstrated pronounced strain-rate dependence, with higher strain rates producing increased stiffness, confirming the viscoelastic nature of the tissues.

Significant differences were also observed between fresh and formalin-fixed specimens. Formalin-fixed tissues exhibited substantially greater stiffness and load-bearing capacity, with peak stresses exceeding 1000 kPa, whereas fresh tissues generally remained below 500 kPa. In contrast, fresh tissues showed greater extensibility and different post-peak softening behaviour. These effects are attributed to chemical cross-linking induced by formalin fixation, which restricts fibre mobility and alters tissue deformation and failure mechanisms.

Mechanical variability was further identified among different muscle groups, with the zygomaticus major exhibiting the highest stiffness and strength, while the masseter displayed lower peak stress and earlier failure. Progressive post-peak stress reduction in all samples suggests the presence of fibre rupture and microstructural damage processes.

These findings provide important experimental data for understanding facial muscle mechanics and demonstrate the necessity of accounting for both strain-rate sensitivity and preservation effects when developing constitutive models for clinically relevant biomechanical simulations.

O15**Biomedical Imaging II: advanced imaging and physiological measurement****Friday 4 September 2026** · 10:20-11:20 · Space Six**Chairs:** Dr Rory Bennett · Dr Hannah Leese

Accelerated photoacoustic microscopy using transfer learning-enhanced latent diffusion reconstruction

Mr Feng He, Mr Yu Pang Lui, Mr Ziyu Ye, Professor Christos Bergeles, Professor Sebastien Ourselin, Professor Keyoumars Ashkan, Dr Wenfeng Xia

Scheduled presenter: Mr Feng He · **Organisation:** King's College London · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 125

DESCRIPTION OF PROPOSED TALK

Photoacoustic microscopy (PAM) combines optical excitation and ultrasonic detection to map optical absorption with microscopic spatial resolution. As a label-free imaging platform, PAM has potential for applications requiring rapid high-resolution assessment over relatively large tissue areas, including intraoperative histology of excised specimens, microvascular imaging and high-throughput biomedical microscopy. In these settings, imaging speed is not only a technical convenience but a translational requirement: slow acquisition can limit field of view, reduce clinical practicality and increase the risk of motion or sample-related artefacts. However, high-resolution PAM normally requires dense spatial sampling, and the achievable acquisition rate is constrained by the finite pulse repetition rate of the excitation laser. Sparse sampling can substantially accelerate acquisition, but undersampled PAM images lose spatial detail and may distort fine morphological structures.

We developed a transfer learning-enhanced latent diffusion reconstruction framework for accelerated PAM. The undersampled image is modelled as a degraded observation of an unknown fully sampled PAM image under a known sampling operator. Posterior sampling with latent diffusion (PSLD) is used as the core inverse-problem solver, combining a pre-trained latent diffusion image prior with measurement consistency to recover missing spatial information from sparsely sampled data. To improve adaptation to PAM, a transfer-learning stage is incorporated to reduce the mismatch between generic diffusion priors and photoacoustic image statistics, improving reconstruction of absorption-based morphology while retaining consistency with the acquired measurements.

The method is evaluated using two complementary PAM datasets acquired at different optical wavelengths. The first dataset consists of PAM images acquired at 266 nm from human breast and prostate tissues, where the reconstructed structures are nuclear features relevant to label-free photoacoustic histology. The second dataset consists of PAM images of murine microvasculature acquired at 532 nm, where reconstruction quality is assessed by preservation of vessel continuity, branching patterns and fine vascular morphology. This evaluation design examines whether the framework can generalise across wavelength-dependent absorption contrast, tissue type and image morphology.

The method is compared with established undersampled PAM reconstruction approaches, including fully dense U-Net reconstruction, DiffPam and generative diffusion prior-based sparse reconstruction. Evaluation uses structural similarity index measure, peak signal-to-noise ratio, Pearson correlation coefficient, line-profile analysis and visual assessment under different undersampling ratios. This work investigates whether transfer learning-enhanced latent diffusion reconstruction can improve the speed-resolution trade-off in PAM, enabling faster large-area imaging for label-free histology, microvascular imaging and clinically practical biomedical microscopy.

015**Biomedical Imaging II: advanced imaging and physiological measurement****Friday 4 September 2026** · 10:20-11:20 · Space Six**Chairs:** Dr Rory Bennett · Dr Hannah Leese

Deep Learning and Image Processing Pipeline for Robust Retinal Layer Segmentation from Multi-Device OCT B-Scans

Mr Yehia Ibrahim

Scheduled presenter: Mr Yehia Ibrahim · **Organisation:** University of Liverpool · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 164

DESCRIPTION OF PROPOSED TALK

Optical coherence tomography (OCT) imaging has emerged as an important non-invasive modality for investigating retinal structural alterations associated with neurodegenerative disorders. However, accurate retinal layer segmentation remains challenging due to noise, image artefacts, inter-device variability, and ocular pathologies. Therefore, this work presents a robust segmentation pipeline for retinal layer analysis from OCT B-scans acquired using multiple OCT systems.

A total of 2048 manually annotated OCT B-scans were collected from Zeiss, Heidelberg Spectralis, and RTVue XR Avanti devices across two hospitals in Ningbo, China. The dataset included both healthy and pathological eyes, including age-related macular degeneration and diabetic retinopathy cases. Nine retinal layers, spanning from the retinal nerve fibre layer (RNFL) to the retinal pigment epithelium (RPE), were considered for the segmentation task.

The proposed framework utilised nnU-Net due to its self-configuring capabilities and automated optimisation of pre-processing, architecture configuration, and training strategies. Five-fold cross-validation was adopted during training. Prior to segmentation, a dedicated pre-processing pipeline was developed, including OCT B-scan cropping, denoising, horizontal alignment correction, and artefact removal. Denoising was performed using neighbouring slice registration combined with structural similarity index (SSIM)-guided averaging to suppress speckle noise whilst preserving retinal structures.

The developed pipeline further incorporated semi-automated rotational alignment correction, fovea-centred cropping, and interpolation of poor-quality B-scans using adjacent slices. In addition, a custom graphical user interface was developed to facilitate manual quality review and automated exclusion of corrupted B-scans.

The proposed framework achieved robust retinal layer segmentation across OCT scans from multiple devices and pathological cohorts. The nnU-Net model trained on nine retinal layers (RNFL-RPE) achieved a mean Dice score of 0.9323 ± 0.0017 and IoU of 0.8770 ± 0.0028 in five-fold cross-validation, with consistent performance across folds. On an external multi-device test set, performance reduced to Dice 0.8714 ± 0.0286 and IoU 0.7816 ± 0.0415 , reflecting expected domain shift. These segmentation methods facilitate the extraction of structural retinal biomarkers relevant to neurodegenerative disorders and cognitive decline.

O15**Biomedical Imaging II: advanced imaging and physiological measurement****Friday 4 September 2026** · 10:20-11:20 · Space Six**Chairs:** Dr Rory Bennett · Dr Hannah Leese

Optical Nanoscopy for Real-Time Investigation of Nano-Bio Interactions in Biomedical Engineering

Dr Francesco Giorgi

Scheduled presenter: Dr Francesco Giorgi · **Organisation:** University of Liverpool · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 185

DESCRIPTION OF PROPOSED TALK

Understanding how micro- and nanoscale entities move, interact, aggregate, and respond to complex biological environments is essential for the development of advanced biomedical technologies, including targeted drug delivery systems, nanomedicine platforms, biosensors, and organ-on-chip models. However, many conventional imaging and characterisation approaches require fluorescent labelling, extensive sample preparation, or endpoint analysis, which can alter particle behaviour and limit the ability to monitor dynamic processes in real time. Here, we present the capabilities of a label-free optical technique based on caustics for the real-time investigation of micro- and nanoscale dynamics in biologically relevant environments.

The technique exploits the optical interference patterns generated when nano- or micro-objects interact with transmitted light under controlled illumination conditions. These caustic signatures enable the visualisation and tracking of objects that are below, or close to, the conventional optical resolution limit, without the need for fluorescent labels or chemical modification. By analysing the evolution of these optical patterns over time, it is possible to extract information on particle motion, diffusion, aggregation, sedimentation, and interactions with surrounding media, surfaces, or biological structures.

This approach offers a versatile platform for studying phenomena that are highly relevant to biomedical engineering. In drug delivery research, caustics-based imaging can support the investigation of nanoparticle transport, stability, and interaction with model biological barriers, providing insight into how formulation properties and environmental conditions affect delivery performance. In nanorheology, the motion of nano-objects can be used as a probe to infer local changes in the physical properties of complex fluids, hydrogels, extracellular matrix-like materials, or tissue-mimicking environments. The same platform can also be applied to monitor nano-bio interactions, including particle-cell interactions, bacterial or bacteriophage dynamics, biofilm formation, and the behaviour of engineered nano-objects in physiological media. This creates opportunities for real-time, non-invasive monitoring of processes that are often difficult to capture using conventional methods. Overall, caustics-based optical nanoscopy provides a powerful and adaptable tool for characterising nanoscale dynamics and interactions in biomedical systems. Its ability to operate label-free and in real time positions it as a promising technology for advancing drug delivery studies, nanomedicine development, biophysical characterisation, and the broader investigation of micro- and nanoscale phenomena in complex biological environments.

O15**Biomedical Imaging II: advanced imaging and physiological measurement****Friday 4 September 2026** · 10:20-11:20 · Space Six**Chairs:** Dr Rory Bennett · Dr Hannah Leese

Velocity Profile of Super Resolution Ultrasound Imaging of Laminar Flow

Miss Leah Douglas, Dr Katy Tant, Dr Helen Mulvana, Prof Tony Gachagan

Scheduled presenter: Miss Leah Douglas · **Organisation:** University of Glasgow · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 218

DESCRIPTION OF PROPOSED TALK

Super Resolution Ultrasound (SRUS) is a contrast enhanced technique used to image blood flow beyond the diffraction limit of conventional ultrasound imaging (half of the spatial pulse length) [1]. The technique relies on diluted microbubble (MB) suspensions so that individual bubbles can be identified and tracked over time. With knowledge of the flow and frame rates used to acquire the data, quantitative information such as MB velocity can be determined in post processing giving insight into the local environment the MBs experience. By localising individual MBs and tracking across multiple frames of data, a map can be provided of its trajectory and flow speeds.

This work used a linear flow phantom with a constrained path to produce a controlled velocity profile of microbubble flow within a 200 μm capillary fibre. Data was acquired using a 7.812 MHz probe (Verasonics, Kirkland, USA) using pulse inversion imaging, yielding an initial spatial resolution of approximately 100 μm . Through post processing using SRUS techniques, the effective resolution was increased to ~ 10 μm with a penetration depth of ~ 50 -80 mm. To achieve a resolution of ~ 10 μm with conventional imaging alone, an extremely high frequency probe (~ 150 MHz) would be required, much beyond the range of clinical scanners (2-15 MHz) and would only provide a penetration depth of ~ 3 -4 mm.

These results demonstrate the capability of SRUS to enhance the spatial resolution without sacrificing penetration depth and provide detailed quantitative information on microbubble dynamics. While previous studies have visualised velocity distribution in the image domain [2], this work extracts a velocity profile across the whole vessel cross-section, revealing a Gaussian-like distribution in both velocity and flow with the majority of microbubbles located through the centre of the fibre. The highest velocity and largest bubbles were observed in the centre of the fibre with the slowest and smallest bubbles at the extremities, as predicted by laminar flow theory. Moreover, the mean speed across each scan line associated with the fibre's location remains consistently around the average value (half maximum) despite the overall Gaussian-like distribution.

Future work will extend this approach to track directionally unconstrained MB flow in tissue phantoms to provide quantitative data on tissue microenvironments and infer information on the nature of organ.

O15**Biomedical Imaging II: advanced imaging and physiological measurement****Friday 4 September 2026** · 10:20-11:20 · Space Six**Chairs:** Dr Rory Bennett · Dr Hannah Leese

Dynamic Neurotransmitter Measurements in Human Derived Systems as Diagnostic and Therapeutic Approaches for Mental Health Disorders

Dr Parry Hashemi

Scheduled presenter: Dr Parry Hashemi · **Organisation:** Imperial College London · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 223

DESCRIPTION OF PROPOSED TALK

Introduction

Diagnosis and treatment of depression remain a great challenge because of lack of measurable clinical biomarkers. In this work, we present real time neurotransmitter measurements in human derived iPSCs differentiated into neurons. First, we describe how we engineered electrodes and software to enable to measurements. Second, we describe how neurotransmitter signals respond to different stimuli and finally we investigate differences in signals from cells derived from different humans.

Methods

We employ a method called fast scan cyclic voltammetry (FSCV) at carbon fiber microelectrodes (CFMs). We fabricate CFMs by hand by aspiration of a single carbon fiber into a glass capillary and then heat and gravity sealing. The exposed part of carbon fibers are cut to 150 μm under a microscope. An electrochemical waveform specific for neurotransmitters is applied to the electrode which, at the same time, identifies and quantifies neurotransmitters in real time.

Results

& Discussion

We found that human derived serotonergic spheroids reliably release and reuptake serotonin. Serotonin is the target of most antidepressants; therefore we exposed the spheroids to selective serotonin reuptake inhibitors and we found significant effects. We also found that the spheroids respond to inflammatory modulators as a model for depression. Finally, we find that the serotonin signals from cells derived from different humans differ significantly from each other.

Conclusion

In conclusion we find that we can model many important facets of depression in human derived spheroids by measuring neurotransmitters in real time.

015**Biomedical Imaging II: advanced imaging and physiological measurement****Friday 4 September 2026** · 10:20-11:20 · Space Six**Chairs:** Dr Rory Bennett · Dr Hannah Leese

Video-based respiratory rate estimation during cessation of breathing in pre-term infants

Dr Dineo Serame, Professor Lord Lionel Tarassenko, Professor Mauricio Villarroel

Scheduled presenter: Dr Dineo Serame · **Organisation:** University of Oxford · **Programme slot:** 11:10-11:20 · **Order:** 6 · **Paper:** 234

DESCRIPTION OF PROPOSED TALK

Episodes of Cessation Of BrEathing (COBE) are common in pre-term infants and contribute to hypoxaemia, bradycardia, and adverse neurodevelopmental outcomes. As such, continuous respiratory monitoring is required in the Neonatal Intensive Care Unit (NICU) to enable timely detection of COBE episodes. Current monitoring approaches, such as impedance pneumography (IP), rely on adhesive contact sensors, which can contribute to skin injury in fragile infants, interfere with care, and are prone to motion artefacts and false alarms. RGB video cameras offer a promising contact-free alternative monitoring approach. However, reliable estimation of respiratory rate (RR) during COBE episodes using camera-based methods remains a significant challenge. This is because respiratory motion is often reduced or absent during these periods, making RR estimation more susceptible to interference from infant movement and other motion artefacts. Consequently, COBE periods are typically excluded from evaluations of non-contact respiratory monitoring systems in the NICU.

This study investigated the feasibility of estimating RR from RGB video recordings collected from pre-term infants under routine NICU conditions. 430 hours of synchronised video and physiological recordings were acquired across 30 pre-term infants undergoing standard care. Following expert annotation and signal quality assessment, 246 5-minute video segments containing COBE episodes across 24 infants were identified for analysis. A camera-based pipeline for RR estimation incorporating dynamic region-of-interest selection, motion signal extraction, feature detection, and signal quality assessment was developed. A key innovation of the pipeline was an adaptive filter-switching approach that used camera-derived motion signals to switch between respiratory filters optimised for normal breathing and periods of reduced respiratory activity associated with COBE.

RR estimates from the camera-based pipeline were compared against synchronised reference RR measurements from the contact IP. Across the dataset, reference RR ranged from 3 - 161 breaths/min with a mean of 51.6 breaths/min and a standard deviation of 18.5 breaths/min. The camera-based method achieved a Pearson's correlation coefficient of 0.62 and a mean absolute error of 15.3 breaths/min across all analysed episodes. During COBE episodes ($RR \leq 20$ breaths/min), the mean absolute error decreased to 11.2 breaths/min, demonstrating improved performance in the clinically relevant low-respiratory-rate range.

These findings demonstrate the feasibility of video camera-based respiratory monitoring during COBE episodes in pre-term infants under real-world NICU conditions. This work supports the development of monitoring approaches better suited to the needs of vulnerable neonatal populations. Further, there is potential to extend this work for low-cost camera-based monitoring in resource-constrained healthcare settings.

O16**Tissue Engineering II: vascular and organ-on-chip models****Friday 4 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Professor Martin Knight · Professor Hazel Screen

Engineering human neuronal circuits using microfluidics with fluid walls

Mr Joseph Morgan, Dr Ricardo Marquez-Gomez, Dr Federico Nebuloni, Mr Alexandros Spyrou, Dr Quyen Do, Ms Akansha Mehta, Dr Charmaine Lang, Prof Richard Wade-Martins, Prof Edmond Walsh

Scheduled presenter: Mr Joseph Morgan · **Organisation:** University of Oxford · **Programme slot:** 10:20-10:30 · **Order:** 1 · **Paper:** 166

DESCRIPTION OF PROPOSED TALK

Modelling human brain cells within functional circuits is essential in advancing our understanding of many neurological disorders. Current knowledge of brain circuitry is largely derived from animal studies, while work in humans has mostly been limited to imaging in vivo or post-mortem analysis. Recently, a multidisciplinary team has developed new microfluidic tools to build circuits of living human neurons in the lab. We present and validate a system for the long-term culture of neuronal circuits in microfluidic environments confined by fluid walls - made by utilizing the immiscibility of aqueous cell media and the bio-inert fluorocarbon, FC40. Fluid walls are used to create biocompatible, fully accessible microfluidic systems directly within standard tissue cultureware that can dynamically change in both space and time. Microfluidic arrangements are formed by reshaping a thin layer of culture media using a jet of FC40, directed by a fluid printer. Using this approach, any 2D design can be fabricated, and fluid added to generate pressure gradients, creating a functional microenvironment.

The main circuit affected in Parkinson's disease is comprised of cortical, striatal, and dopaminergic neurons. We print microfluidic 'dumbbells' with fluid walls and demonstrate that such arrangements support the long-term culture of all three neuronal subtypes derived from human iPSCs (hiPSCs). Selectively adding fluid to chambers generates pressure gradients within dumbbells, enabling effective confinement of cell types. This facilitates spatial separation for co-culture of different cell types, compartmentalization of somas and dendrites from axons, and unidirectional axon projection. We also show a triple-chamber system allowing coculture of all three neuron types, modelling the full cortico-striatal-dopamine neuronal circuit. All regions are fully accessible through fluid-fluid interfaces and can be reconfigured mid-experiment, users can isolate and harvest from specific regions (cells/media) of interest. Control over the compartmentalisation and directionality of neuronal connections based on fluid dynamics offers an efficient and highly reproducible system for development of human neuronal circuit assays. Finally, we show that these microfluidic arrangements can be fabricated directly within commercially available multi-electrode array plates (MEA), enabling monitoring of signalling between separated neuron sub-groups.

O16**Tissue Engineering II: vascular and organ-on-chip models****Friday 4 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Professor Martin Knight · Professor Hazel Screen

Anti-thrombotic and decalcifying dECM embedded bilayer grafts for vascular tissue engineering

Miss Rosanna Hood, Dr Nicola Green

Scheduled presenter: Miss Rosanna Hood · **Organisation:** University of Sheffield · **Programme slot:** 10:30-10:40 · **Order:** 2 · **Paper:** 1

DESCRIPTION OF PROPOSED TALK

Introduction

640 million people worldwide live with cardiovascular disease [1]. Autografts remain gold standard for vascular replacement, but some patients lack harvestable vessels necessitating synthetic alternatives [2]. However, these fail at smaller diameters due to acute thrombosis and poor reendothelialization. Tissue engineered vascular grafts (TEVG) are aimed to provide off-the-shelf biomimetic alternatives. Citric acid, a naturally occurring reagent, possesses the ability to chelate Ca^{2+} which aims to prevent platelet adhesion and thrombosis. It also aims to decalcify atherosclerotic deposits [3], [4]. This work aims to create a bilayer vascular graft composed of a citrate-eluting inner layer and an outer layer of decellularised extracellular matrix (dECM) embedded porous scaffold. Through extended cell culture and decellularization, a biomimetic TEVG will be created that not only contains native dECM but possesses the potential for in situ treatment.

Materials and Methods

Here we functionalised poly(glycerol sebacate) (PGS) with different molar ratios of citric acid. The polymers were characterised before electrospun mats were produced and studied for mechanical properties, cytotoxicity and hemocompatibility. The outer layer was synthesised from porous scaffolds of PGS- methacrylate and optimised for pore size and interconnectivity to encourage infiltration. Fibroblasts were cultured for 28 days to deposit ECM before decellularisation was completed to produce non-immunogenic scaffolds.

Results

FTIR, NMR and GPC confirmed the production of different compositions of PGS-citrate. Altering the proportions of citrate leads to tunability of the tensile strength, degradation and biocompatibility. Cytotoxicity testing highlighted a favourable composition of PGSC, and platelet adhesion showed a 7-fold reduction. For the outer layer, histological and immunofluorescence staining highlighted thorough infiltration and deposition of ECM. Optimisation of a decellularisation protocol led to DNA content of below the 50 ng/mg threshold. Immunofluorescence and hydroxyproline assay confirmed the retention of ECM components alongside the removal of nuclei. Reseeding with primary cells shows increased proliferation in the presence of the dECM.

Conclusion

Both layers of the vascular graft have been synthesised and studied to confirm their desired properties. PGSC scaffolds show a 7-fold reduction in platelet adhesion providing promise for the prevention of acute thrombosis. An investigation into the decalcification with PGSC will be completed and aims to break down atherosclerotic plaques in vivo. The outer layer contains vital proteins to encourage cell infiltration, and the increased rate of proliferation shows promise for rapid endothelialisation. Incorporation of a dynamic bioreactor culture aims to boost ECM production and cell proliferation to create more robust biomimetic scaffolds.

O16**Tissue Engineering II: vascular and organ-on-chip models****Friday 4 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Professor Martin Knight · Professor Hazel Screen

Temporally resolved insulin and serotonin signalling in pancreatic-like models

Mr Matthew Murphy, Mr Taran Jawa, Dr Anna Bird, Dr Parastoo Hashemi

Scheduled presenter: Mr Matthew Murphy · **Organisation:** Imperial College London · **Programme slot:** 10:40-10:50 · **Order:** 3 · **Paper:** 114

DESCRIPTION OF PROPOSED TALK

Diabetes remains one of the most socioeconomically and personally devastating conditions in the United Kingdom, affecting near 6 million people and costing healthcare services upwards of £7 billion each year. Despite improvements in scientific technology and the introduction of weight loss drugs including glucagon-like peptide 1 receptor agonists which target diabetes type 2 and other sequelae of obesity, there is still a gap in understanding of how diabetes pathogenesis takes place. Improving the fundamental awareness of how the pancreas signals in health and disease and across different organ axis would support the development of targeted therapeutics and potentially facilitate earlier detection, ultimately leading to better patient outcomes. Of the current diagnostic and investigative tools for pancreatic signalling, most lack temporal resolution or specificity. Our lab specialises in a technique called fast scan cyclic voltammetry (FSCV) which generates a unique electrochemical fingerprint for each analyte with incredibly high temporal resolution. FSCV has historically been used for neurotransmitter detection yet here we adapted the technique to detect electroactive residues in peptides like insulin across different physiological models. These include insulinoma cell lines, reaggregated islets and whole pancreatic islets. Furthermore, we applied this technique to interrogate insulin and serotonin co-release in vitro, an area of research previously limited by time resolution of measurement. Using FSCV, we determined the limit of detection for insulin in real-time, designed computational methodologies to disentangle electrochemical fingerprints and demonstrated glucose-stimulated release of insulin and serotonin in physiologically relevant models. This development in the field of electrochemistry offers researchers greater scope to study the mechanisms leading to diabetes and potentially develop interventions for a key chronic health condition.

O16**Tissue Engineering II: vascular and organ-on-chip models****Friday 4 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Professor Martin Knight · Professor Hazel Screen

Biopolymer for cardiac tissue engineering

Mrs NOOR JIBAWI

Scheduled presenter: Mrs NOOR JIBAWI · **Organisation:** University of Leicester · **Programme slot:** 10:50-11:00 · **Order:** 4 · **Paper:** 43

DESCRIPTION OF PROPOSED TALK

Myocardial infarction leads to loss of the function cardiac tissue, and current clinical therapies still limited in their ability to restore myocardial structure and function. In this study, a hybrid scaffold (Bilayer) approach was developed to address the structural and mechanical limitations of conventional cardiac patches by combining electrospinning and freeze-drying techniques. Polyurethane (PU) and waterborne polyurethane (WPU) scaffolds were explored, with gelatine incorporated to enhance bioactivity and mimic extracellular matrix components.

Electro spun nanofibrous membranes were successfully fabricated from PU and WPU-based formulations, where processing conditions were optimised to achieve stable jet formation and continuous fibre deposition. The addition of gelatine influenced fibre morphology, leading to increased fibre diameters and improved uniformity, while aligned fibre structures were obtained to better replicate the anisotropic nature of cardiac tissue. In parallel, freeze-dried gelatine-WPU scaffolds exhibited a highly porous and interconnected architecture, suitable for promoting cell infiltration.

To combine the advantages of both fabrication techniques, bilayer scaffolds were developed by combining the nanofibrous electro spun layer with the porous freeze-dried structure. Crosslinking using EDC/NHS improved scaffold stability without significantly altering the chemical structure, as confirmed by FTIR analysis, consistent with the zero-length crosslinking mechanism. Mechanical testing demonstrated that the scaffolds exhibited distinct behaviour under dry and hydrated conditions, with properties approaching the range required for cardiac tissue applications.

Overall, the results show that combining electrospinning and freeze-drying can produce scaffolds with controlled structure and mechanical properties. This approach offers a useful way to design more biomimetic cardiac patches.

O16**Tissue Engineering II: vascular and organ-on-chip models****Friday 4 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Professor Martin Knight · Professor Hazel Screen

Development of an ex vivo explant perfusion platform that allows continuous real-time metabolite monitoring of precision cut tumour slices

Miss Yilin Ma, Miss Xinyue Liu, Dr Sally Gowers, Prof Martyn G. Boutelle, Prof Darryl R. Overby

Scheduled presenter: Miss Yilin Ma · **Organisation:** Imperial College London · **Programme slot:** 11:00-11:10 · **Order:** 5 · **Paper:** 66

DESCRIPTION OF PROPOSED TALK

Ovarian cancer metabolism is dynamically re-programmed during chemotherapy. Recent in vitro evidence suggests that cisplatin-resistant ovarian cancer cells switch from a glycolysis-dependent state towards oxidative phosphorylation (OXPHOS) dependence, demonstrated by upregulation of OXPHOS genes, increased glucose uptake yet reduced lactate production rates 1, 2. However, the timeline of metabolic changes remain difficult to capture in physiologically relevant tumour models, as conventional metabolite measuring assays largely provide only end-point assessments, limiting temporal resolution. To address this, we developed a novel ex vivo precision cut tumour slice (PCTS) platform integrated with in-line glucose and lactate biosensing, enabling real-time monitoring of metabolic responses in bulk tumour explant tissues during chemotherapeutic exposure.

The monitoring system interfaced externally downstream of four connected tissue culture plate wells, each containing one PCTS explant on a transwell, perfused with fresh culture media unidirectionally. A clinically-approved microdialysis probe was positioned at the outlet of the plate to enable perfusate sampling, with tubing connected to needle-sized enzyme-based biosensors developed by our collaborator group for glucose and lactate measurements 3. Briefly, a platinum working electrode inside the biosensor was coated with hydrogel containing either glucose (or lactate) oxidase to oxidise glucose (or lactate) to produce H₂O₂ which was then oxidised at an applied potential (+0.7V), generating a current recorded via amperometry. The current was proportional to analyte concentration, allowing quantitative monitoring in long-term. We brought the glucose sensor and lactate sensor in proximity by parking them onto a 3D-printed microfluidic chip allocated outside the incubator, downstream of the microdialysis outlet. This design not only achieved simultaneous measurements of glucose and lactate in tissue culture media in real-time, but also minimised the drifts in enzymatic biosensing performance caused by the temperature difference between incubator and bench. To support long-term experiments, the biosensors were calibrated every 6-12h with known analytes (glucose and lactate) concentrations using programmable pumps.

So far, we have validated that the sensors are capable of measuring glucose and lactate over the physiological ranges, demonstrating linear standard curves. The optimal microdialysis flow rate was also determined to be 2µl/min. Current work is focussed on applying this platform to healthy murine liver explants, followed by PCTS explants. This platform offers a new approach to monitor metabolic dynamics in ex vivo cancer models, enabling investigations into how metabolic activity changes in response to chemotherapy and how metabolic dysregulation may affect the chemotherapeutic response.

O16**Tissue Engineering II: vascular and organ-on-chip models****Friday 4 September 2026** · 10:20-11:20 · Space Seven**Chairs:** Professor Martin Knight · Professor Hazel Screen

3D Printing of Animal-Free Blood Vessels for Vascular Tissue Engineering

Sushma Priya, Dr Deepak kalaskar, Dr Mahadeo Vishwanie

Scheduled presenter: Sushma Priya · **Organisation:** University College London · **Programme slot:** 11:10-11:20 · **Order:** 6 · **Paper:** 75

DESCRIPTION OF PROPOSED TALK

The continued dependence on animal-derived materials and in vivo models represents a significant constraint in vascular research, introducing ethical concerns while limiting translational fidelity to human physiology. Here, we report the development of a fully animal-free, 3D bioprinted vascular platform engineered to overcome these limitations and enable physiologically relevant in vitro modelling.

Human adipose-derived stem cells (ADSCs) were expanded and lineage-specifically differentiated into endothelial cells (ECs) and smooth muscle cells (SMCs) under strictly animal-origin-free culture conditions, employing recombinant growth factors and human-derived supplements. A biomimetic, animal-free hydrogel formulation was systematically optimised to achieve suitable rheological properties, cytocompatibility, and structural stability for bioprinting applications. Multilayered vascular constructs were fabricated via coaxial extrusion-based 3D bioprinting, consisting of an outer SMC-encapsulated matrix and a central perfusable lumen.

Post-fabrication, the animal-free blood vessels were cultured under dynamic bioreactor perfusion to promote luminal cell alignment and coverage. The engineered constructs exhibited high cell viability (>90%), progressive cellular organisation, and robust lumen integrity over culture duration. Mechanical evaluation demonstrated adequate structural stability, while hemocompatibility assessment revealed reduced platelet adhesion and negligible hemolytic response, indicating functional compatibility with vascular applications.

Notably, the entire fabrication workflow is devoid of animal-derived components, aligning with the principles of non-animal methodologies (NAMs) and advancing the development of ethically compliant research platforms. The resulting vascular constructs hold significant promise for applications in drug screening, disease modelling, and microsurgical training, offering a human-relevant alternative to conventional animal-based systems.

Collectively, this work establishes a scalable and translationally relevant strategy for engineering vascular tissues, contributing to the advancement of regenerative medicine and next-generation biofabrication technologies.

017**Tissue Engineering III: neural, bone and therapeutic implants****Friday 4 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Dr Jenny Hanson · Dr Tecla Bonci**Aligned cellulose coatings on dopamine-functionalised gelatin methacrylamide (GelDMA) hydrogels: comparing nanocrystal and nanofibre topographies for myoblast alignment**

Dr Sevgi Balcioglu, Prof Julie Gough, Dr Ahu Gumrah Dumanli-Parry, Dr Matthew Graham

Scheduled presenter: Dr Sevgi Balcioglu · **Organisation:** Sakarya University of Applied Sciences · **Programme slot:** 13:00-13:10 · **Order:** 1 · **Paper:** 151**DESCRIPTION OF PROPOSED TALK**

Skeletal muscle injuries that exceed the regenerative capacity of resident satellite cells, particularly volumetric muscle loss, lead to fibrotic scarring and lasting motor deficits, while autologous grafts remain limited by donor site morbidity. Functional repair requires myoblasts to align and fuse into oriented myotubes [1]. Spin-coated tunicin cellulose nanowhiskers, 10-20 nm in diameter, were previously shown to direct myoblast orientation and radial myotube formation on glass [2]. However, whether more accessible cellulose sources with lower aspect ratios can reproduce this guidance, and whether the effect transfers to a softer, wet-adhesive substrate closer to native muscle (~10-50 kPa) than rigid glass, remains unclear.

To address this, cotton-derived cellulose nanocrystals (CNCs) and longer cellulose nanofibres (CNFs) were compared as topographical coatings on a GelDMA platform. GelMA was synthesised at three methacrylation degrees (0.1, 0.4, and 0.8 mL methacrylic anhydride per gram of gelatin) and combined with dopamine methacrylamide (DMA). GelDMA was spin-coated onto glass, photocured with LAP, and over-coated with CNCs or CNFs at 3000-12000 rpm. Hydrogels were characterised by swelling, compression, rheology and injectability, and cellulose alignment was confirmed by AFM with Fiji orientation analysis. C2C12 attachment, alignment, and myogenic differentiation were assessed by Live/Dead staining, phase-contrast imaging, and immunofluorescence staining for F-actin, vinculin, and DAPI.

Compressive strength scaled with crosslinking density and stayed within the native muscle range (~19 kPa at 0.1 mL/g, ~38 kPa at 0.8 mL/g, $p < 0.05$). DMA was retained covalently, with cumulative release below 10% over 11 days, and dopamine functionalisation enhanced thixotropic recovery. The hydrogel precursors also extruded cleanly through 22 G and 27 G needles. CNCs aligned uniaxially on the GelDMA surface as confirmed by AFM, yet C2C12 cells did not follow this alignment in any formulation. CNFs gave a different outcome: from 8000 rpm onwards cells elongated along the coating direction, and under differentiation conditions myotube-like structures appeared by Day 7, even though AFM at that speed showed only modest fibre order.

These results point to fibre length and continuity, rather than nanoscale crystalline order alone, as the dominant cue for myoblast guidance, and indicate that low aspect ratio CNCs cannot replace longer nanowhiskers or nanofibres in this role. CNF-coated GelDMA combines wet adhesion, compliance within the native muscle range, and effective topographical guidance, providing a workable 2D substrate on a more physiologically relevant base than rigid glass, and supporting future development of 3D scaffold systems for skeletal muscle repair.

017**Tissue Engineering III: neural, bone and therapeutic implants****Friday 4 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Dr Jenny Hanson · Dr Tecla Bonci**Visualising Tissue Development in a Bioceramic Scaffold**

Miss Aalia Rehman, Professor Simon C F Rawlinson, Professor Karin A Hing

Scheduled presenter: Miss Aalia Rehman · **Organisation:** Queen Mary University of London · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 165**DESCRIPTION OF PROPOSED TALK****Introduction**

Tissue engineering encourages the culture of cells within a 3D environment to more closely replicate in vivo physiological conditions and native cellular interactions compared to conventional 2D systems. Successful 3D tissue constructs benefit from porous architectures to support cell migration, nutrient diffusion, and waste removal. In bone tissue engineering, porous scaffolds of bioceramics such as hydroxyapatite are incorporated to provide a biologically relevant environment for promoting osteogenic differentiation of human mesenchymal stem cells, for up to 28-days to enable the generation of a matrix embedded cell population. A major challenge is the inability to visualise the cell-matrix formation within the scaffold due to the hardness and opacity of bioceramics. Conventional decalcification methods reduce scaffold rigidity but often compromise structural integrity and spatial resolution, limiting the reliability of subsequent staining and imaging techniques. Alternatively, resin embedding and grinding techniques allow for only a few sections, limiting analysis.

Methods

To address these limitations, a novel embedding and decalcification method using non-specialist chemicals and tools was developed to preserve the structural integrity of organic tissue formed within and around the scaffold. A double-embedding technique was required to enable high-quality sectioning using a standard cryostat. Low-gelling agarose was identified as the most suitable primary embedding media to preserve tissue morphology and stabilise the mineralised scaffold during acid-mediated decalcification. Following removal of the mineral phase, a secondary embedding medium filled the scaffold voids, enabling stable ultra-thin sectioning. Histological and immunohistochemical analyses were performed and correlated with both the scaffold architecture and the proteomic analyses quantifying osteogenic markers, including Collagen I.

Results**& Discussion**

The developed method enabled enhanced visualisation of cellular distribution, extracellular matrix deposition, and tissue integration throughout the porous scaffold architecture. Preservation of section integrity following staining confirmed the effectiveness of the embedding strategy, with scaffold pore structures remaining visible after processing. The method enabled detailed evaluation of cell-scaffold and cell-cell interactions within the scaffold over 7-28 days, even confirming cell migration within small pore (<20 µm) architecture. This approach overcomes longstanding imaging and characterisation challenges associated with optically opaque bioceramics and improves analysis of engineered bone tissue formed on bioceramic substrates.

Conclusions

This advanced embedding and decalcification method provides a robust platform for the characterisation of tissue development within optically opaque 3D scaffolds. By enabling accurate preservation and visualisation of biological interactions within engineered bone constructs, the approach supports the advancement of predictive in vitro bone models and regenerative medicine applications.

017**Tissue Engineering III: neural, bone and therapeutic implants****Friday 4 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Dr Jenny Hanson · Dr Tecla Bonci**Personalised Organotypic Bone Fracture Models for Osteogenesis Imperfecta Treatment Development**

Miss Ilona Bognar, Dr Gian Schädli, Dr Chris Steffi, Professor Meena Balasubramanian, Dr Nicola Green, Dr Michael Trikid, Professor Gwendolen Reilly, Professor Ralph Müller

Scheduled presenter: Miss Ilona Bognar · **Organisation:** University of Sheffield · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 190**DESCRIPTION OF PROPOSED TALK**

Osteogenesis Imperfecta (OI) is a rare genetic disorder caused by defective type I collagen synthesis and processing, resulting in brittle bones. Conventional 2D static monolayer cultures used to study OI fail to replicate the structural and mechanical characteristics of native 3D bone tissue. This limits their ability to model the mineralised, collagen type I-rich extracellular matrix (ECM) and to capture patient-specific bone pathology relevant to fracture susceptibility in OI. Furthermore, these models offer limited potential for investigating individualised therapeutic responses, highlighting the need for more physiologically relevant and patient-specific in vitro systems that cannot be achieved with conventional animal models.

This study presents a mechanically stimulated 3D bioprinted bone model using a two-step extrusion bioprinting and reseeding process with OI patient-derived osteoblasts. The model was designed to recapitulate osteoblastic and osteocyte-like phenotypes, as previously demonstrated [1], while providing a platform for studying disease mechanisms and evaluating personalised treatment strategies in a physiologically relevant bone microenvironment.

Primary human osteoblasts (hOBs) isolated from an osteogenesis imperfecta patient carrying a COL1A1 c.2461G>A (p.Gly821Ser) glycine substitution mutation were embedded in an alginate-gelatin-graphene oxide hydrogel and fabricated via 3D extrusion bioprinting. The resulting 7.5 mm × 7.5 mm × 2.5 mm constructs were subsequently subjected to uniaxial compressive loading (1% strain, 5 Hz for 5 minutes, three times per week) over a four-week period, under osteogenic conditions. Following initial mineralisation, the constructs were top-seeded with fresh hOBs to enhance surface cell repopulation and further matrix deposition. The constructs were then cultured for an additional four weeks with 5 mM 4-phenylbutyric acid, a chemical chaperone, and mechanical loading, both independently and in combination, to investigate their effects on collagen deposition and temporal ECM mineralisation in OI.

Longitudinal mineralisation dynamics, such as total mineral volume, formation rate and density were assessed using time-lapsed micro-computed tomography (micro-CT), while collagen organisation and deposition were characterised through Sirius red staining and immunostaining techniques. In addition, construct stiffness was evaluated after fifty-six days to examine the potential effects of mechanical stimulation and chemical chaperone treatment on OI tissue maturation and functional properties.

By providing a reproducible, mechanically active, patient-specific 3D bone model, this platform enables controlled investigation of ECM mineralisation, collagen organisation, and mechanobiological responses in OI, and may facilitate more physiologically relevant preclinical screening of candidate therapeutics.

017**Tissue Engineering III: neural, bone and therapeutic implants****Friday 4 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Dr Jenny Hanson · Dr Tecla Bonci**In-situ alginate gelation using Rheodialysis as a tool for tissue engineering applications**

Mr Florian Rummel, Dr. Lai Zhang, Prof. John Girkin, Dr. Sabrina Kuespert, Dr. Anders Aufderhorst-Roberts

Scheduled presenter: Mr Florian Rummel · **Organisation:** NETZSCH Analyzing & Testing · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 221**DESCRIPTION OF PROPOSED TALK**

Hydrogel structures with defined rheological properties are of crucial importance for applications in the field of tissue engineering. Small changes in the chemistry of a sample of the material can influence the resulting rheological and biomechanical properties of the fabricated structure on both time and length scales.

In this contribution, we present rheodialysis, an approach that enables the rheological characterisation of alginate gelation under varying chemical compositions. In this example, calcium ions are introduced into the alginate solution sample through a semi-permeable membrane beneath the lower plate of a rotational rheometer using syringe or peristaltic pumps.

The temporal and spatial gelation is illustrated by analyzing the gelation point under various experimental conditions, such as the measurement gap and time, and the dependence on the experimental parameters is demonstrated and discussed.

The results of this study provide the basis for a precise temporal and spatial characterisation of the kinetics of alginate gelation, thereby laying the groundwork for stable processes in tissue engineering.

017**Tissue Engineering III: neural, bone and therapeutic implants****Friday 4 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Dr Jenny Hanson · Dr Tecla Bonci**Development of a GelMA Hydrogel Micromembrane Platform for Osteosarcoma Invasion Modelling**

Dr Yifei Wan, Mr Bowen Jia, Prof Will Shu

Scheduled presenter: Dr Yifei Wan · **Organisation:** University of Strathclyde · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 222**DESCRIPTION OF PROPOSED TALK**

Osteosarcoma invasion is regulated by complex interactions between malignant cells, stromal cues, and remodelable extracellular matrix barriers (1). However, conventional in-vitro invasion models, such as fixed commercial inserts or bulk hydrogel systems, often provide limited control over microscale geometry, matrix structure, and imaging accessibility (2, 3). Existing platforms rarely combine a rigid, bone-inspired microstructure with a soft, cell-adhesive matrix interface in a format suitable for quantitative vertical invasion studies (4, 5). To address these challenges, a novel 3D-printed rigid-soft micropore platform has been developed for the investigations into matrix remodelling and osteosarcoma-stromal interactions. This platform comprises a resin scaffold compatible with standard 24-well plates, featuring arrays of 400 μm microholes. Gelatin methacryloyl (GelMA) is photocrosslinked across these microholes to form suspended hydrogel membranes. The rigid scaffold offers a geometrically defined, trabecular bone-inspired architecture, while the GelMA membrane acts as a soft, cell-adhesive, and potentially enzymatically degradable matrix interface. This rigid-soft scaffold provides a basis for constructing a controllable vertical invasion model, in which osteosarcoma cells could be seeded on the upper GelMA interface, while 3T3 fibroblasts or fibroblast-conditioned medium could be introduced beneath the membrane to provide stromal paracrine cues. Overall, this preliminary 3D-printed GelMA micropore platform demonstrates the feasibility of integrating rigid microscale structure with suspended soft hydrogel micromembranes. It provides an imaging-compatible and customisable framework for developing physiologically relevant in vitro models of osteosarcoma invasion and, in future studies, may support anti-invasive drug screening applications.

O17**Tissue Engineering III: neural, bone and therapeutic implants****Friday 4 September 2026** · 13:00-14:00 · Space One and Two**Chairs:** Dr Jenny Hanson · Dr Tecla Bonci**3D-printing of temperature sensitive and drug-eluting hydrogel-based cardiovascular implants**

Ms Elizabeth Seed, Dr Lisa Ascaik, Ms Sarah Eccles, Ms Amy Carnegie, Dr Christopher McCormick

Scheduled presenter: Ms Elizabeth Seed · **Organisation:** University of Strathclyde · **Programme slot:** 13:50-14:00 · **Order:** 6 · **Paper:** 231**DESCRIPTION OF PROPOSED TALK**

Recent medical advances have revolutionised cardiovascular surgery through the development of cutting-edge, life-saving implants, such as vascular stents, grafts, and heart valves. Nevertheless, an ideal implant which meets all the criteria for safe, effective, and long-term use remains to be achieved (1). The longevity and accessibility of implants are critical as the global population continues to age. Other major challenges include: (1) lack of patient-specificity, (2) mechanical mismatches, where implant materials are much stiffer than the surrounding tissue, and (3) infection following implantation, which are very difficult to treat (1). 3D printing using novel material combinations, including hydrogels, has emerged as a highly promising technology to address these challenges, primarily due to its ability to replicate patient-specific geometries and anatomical complexities. Previous work (2) demonstrated successful fabrication of an alginate: poly(ethylene glycol) diacrylate (PEGDA) hydrogel compatible with light-based 3D-printing for the fabrication of aortic grafts.

This research builds upon previous work (2) by investigating the addition of (i) NIPAM to improve the mechanical behaviour of the material, and (ii) active agents to prevent infection and thrombosis towards more patient-specific cardiovascular implants. The active agents investigated will be the antibiotic rifampicin (RIF), which is a broad-spectrum antibiotic typically applied to vascular grafts to prevent infection [3].

Methods

The hydrogel formulations were prepared in different combinations of GelMA and PEGDA, NIPAM (13.5%), and one group had the addition of rifampicin (1mg/ml).

To create 3D printed samples the material calibration curves were created with light intensity and exposure time/ 50um layer thickness recorded.

Uniaxial tensile testing was carried out to obtain the Young's modulus, ultimate tensile strength, and suture retention tests (Biomomentum, 0-250 N load cell). 3D printed, dog-bone, samples (n=3) . The NIPAM samples were tested at 24°C and 37 °C.

The drug eluting study of the samples took place over one week, the efficacy of the print was measured using *S.aureus* bacteria.

Results

The tunability of the different hydrogels was investigated and found that the NIPAM samples had a higher Young's Modulus when tested at 37 °C. It was found that the addition of GelMA increased the Young's Modulus.

Rifampicin was eluted from the hydrogel within the first 50 hours.

A thin blood vessel with inner diameter 1.8 mm of the NIPAM samples were printed and temperature change on the dimensions observed.

O18**Computational Modelling III: organ-scale biomechanics****Friday 4 September 2026** · 13:00-14:00 · Space Four**Chairs:** Professor Michael Sutcliffe · Mr YuChun Chou

Patient-Specific Finite Element Modelling of Posterior Cranial Vault Distraction in Apert Syndrome

Ms Ruonan Dong, Dr Ce Liang, Mr Yunus Samiepour, Dr David Johnson, Dr Wuyang Shui, Dr Christian Duncan, Dr Roman H. Khonsari, Dr Giovanna Paternoster, Prof Mehran Moazen

Scheduled presenter: Ms Ruonan Dong · **Organisation:** University College London · **Programme slot:** 13:00-13:10 · **Order:** 1 · **Paper:** 200

DESCRIPTION OF PROPOSED TALK

Background

Apert syndrome is a severe form of syndromic craniosynostosis - a genetic condition characterised by premature fusion of cranial joints, leading to restricted skull growth and elevated intracranial pressure (ICP). Posterior cranial vault expansion (PCVE) is a key surgical intervention to relieve ICP and accommodate brain growth, and can be achieved through different distraction techniques: rigid distractors, springs, and free-floating bone flap¹. However, direct clinical comparison of these modalities is methodologically challenging. Computational modelling offers a controlled framework to evaluate and compare these techniques without patient risk.

Methods

A patient-specific finite element (FE) model was constructed from the CT scan of a child with Apert syndrome who underwent supratentorial PCVE with rigid distractors at Necker-Enfants Malades Hospital. The model was validated against the clinical outcome. The validated model was then used to virtually simulate two alternative techniques - springs and free-floating bone flap - and all three were compared in terms of intracranial volume (ICV) and craniometric distances.

Results

All three modalities produced measurable ICV gains relative to the baseline CT volume of 1,524.47 cm³ (D294 - 294 days old). Rigid distractors achieved the greatest expansion with a gain of 262.93 cm³ (final ICV: 1,787.40 cm³), nasion- internal occipital protuberance (IOP) of 141.1 mm, and basion-IOP of 100.2 mm at D476. Springs yielded a gain of 202.75 cm³ (1,727.22 cm³), nasion-IOP of 133.8 mm, and basion-IOP of 95.0 mm. Free-floating bone flap produced the most modest gain of 78.15 cm³ (1,602.62 cm³), nasion-IOP of 126.0 mm, and basion-IOP of 85.9 mm.

Conclusions

This study presents the first patient-specific FE framework for virtual comparison of distraction modalities in supratentorial PCVE for Apert syndrome. By simulating rigid distractors, springs, and free-floating bone flap within the same validated model, we demonstrate that all three techniques achieve meaningful ICV expansion, with rigid distractors producing the largest and most sustained volumetric gains. This computational approach enables controlled surgical comparisons not feasible in clinical practice, offering a powerful tool to guide evidence-based decision-making in cranial vault surgery.

O18**Computational Modelling III: organ-scale biomechanics****Friday 4 September 2026** · 13:00-14:00 · Space Four**Chairs:** Professor Michael Sutcliffe · Mr YuChun Chou

Convergence of Turbulent Kinetic Energy in Aortic Flows: Evaluating Sensitivity to the Number of Simulated Cardiac Cycles.

Miss Kathryn Barker, Dr Jie Wang, Dr Emily Manchester, Prof Alistair Revell

Scheduled presenter: Miss Kathryn Barker · **Organisation:** University of Manchester · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 201

DESCRIPTION OF PROPOSED TALK

High-fidelity Computational Fluid Dynamics (CFD), such as Large Eddy Simulation (LES), enables the accurate assessment of cardiovascular turbulence biomarkers like turbulent kinetic energy (TKE). However, the computational cost of LES is substantial. Calculating phase-averaged TKE requires simulating multiple cardiac cycles, yet there are currently no established guidelines regarding the minimum number of cycles needed to achieve proper convergence. This requirement fluctuates based on the specific anatomy, cardiac phase, and whether the targeted metrics are point-wise or spatially averaged. To ensure computational feasibility, it is essential to minimise simulated cycles without sacrificing accuracy. This study addresses this by evaluating the sensitivity of TKE convergence to the number of simulated cardiac cycles in a healthy adult aorta.

We systematically compare point-wise, slice-averaged, and volume-averaged TKE to quantify how spatial averaging affects convergence rates. Ultimately, this work aims to establish best-practice guidelines, enabling researchers to ensure accuracy at minimal computational cost. Magnetic Resonance Images (MRI) from a healthy adult aorta were used to segment the aortic geometry. Blood flow was modelled using LES with the WALE Subgrid-Scale (SGS) model. LES was selected for its capabilities in modelling laminar, transitional and turbulent flows. LES requires a well-resolved mesh and consisted of 4.5 million hexahedral cells with a time-step of 0.2 ms. At the three branch and descending thoracic aorta outlets, a 3-element Windkessel model was applied. At the inlet boundary, 4D flow MRI was used to implement a patient-specific 3D velocity profile, representative of the patient's entire cardiac cycle. To evaluate TKE sensitivity to the number of simulated cardiac cycles, we evaluate point-wise, 2D slice-averaged and 3D volume averaged TKE. These metrics will be calculated from OpenFOAM simulation data using ParaView and Python-based post-processing. These metrics provide local quantification of turbulence intensity, spatially distributed cross-sectional averages at locations chosen in accordance with previous research group studies for methodological consistency, and a global measure of the average turbulent kinetic energy across the computational aortic domain.

The results of this study aim to outline practical guidelines regarding the required number of simulated cardiac cycles for computationally efficient yet converged LES. This study will provide guidance in assessments of LES in patient specific aorta geometry for the authors PhD body of work. This work will apply a level of confidence to these simulation and will further inform a critical methodology for physiologically realistic LES. Contributing towards the development of best-practice guidelines for reliable and computationally feasible cardiac LES.

O18**Computational Modelling III: organ-scale biomechanics****Friday 4 September 2026** · 13:00-14:00 · Space Four**Chairs:** Professor Michael Sutcliffe · Mr YuChun Chou

Sensitivity Analysis of Pulsatility Transmission to the Cerebral Microvasculature

Mr William Greenough, Dr Wahbi El-Bouri

Scheduled presenter: Mr William Greenough · **Organisation:** University of Liverpool · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 209

DESCRIPTION OF PROPOSED TALK

Background

Cerebral small vessel disease is a leading contributor to cognitive decline and dementia, yet the hemodynamic mechanisms driving microvascular damage remain incompletely understood [1]. Increasing evidence suggests that excessive pulsatility transmitted from large arteries into the delicate cerebral microvasculature plays a central role in this pathology - a concept termed pulse wave encephalopathy [3]. Elevated pulsatility indices measured in cerebral arteries have been consistently associated with white matter hyperintensities, reduced cognitive performance, and increased dementia risk [1,3]. Despite these clinical observations, limited computational modelling work has been undertaken to systematically identify which physiological and geometric factors are most responsible for governing the transmission of pulsatility into the distal microvascular bed. Understanding these determinants is critical for identifying at-risk populations and developing targeted therapeutic strategies [1].

Methods

We employed a one-dimensional dynamic blood flow model to simulate pulse wave propagation through the cerebral arterial network. Simulations were performed across 56 patient-specific vascular geometries derived from the BraVa (Brain Vasculature) dataset, which provides detailed three-dimensional reconstructions of the human cerebral vasculature obtained from magnetic resonance angiography [2]. A comprehensive sensitivity analysis was conducted by systematically varying key model parameters - including arterial wall stiffness, mean arterial blood pressure, terminal resistance, and inlet waveform characteristics - across the full set of anatomical geometries. Pulsatility index and other hemodynamic metrics were evaluated at multiple locations throughout the vascular tree to quantify how each parameter influenced the degree of pulsatility reaching the microvascular level.

O18**Computational Modelling III: organ-scale biomechanics****Friday 4 September 2026** · 13:00-14:00 · Space Four**Chairs:** Professor Michael Sutcliffe · Mr YuChun Chou

Computational Flow Modelling of Coronary Haemodynamics using Hierarchical Phase-Contrast Imaging (HiP-CT)

Mr Akash Sivananthan, Dr. Kaihong Wang, Dr. Joseph Brunet, Ms. Emer O'Leary, Dr. Edo Occhipinti, Dr. Claire L. Walsh, Prof Christos V. Bourantas, Prof Ryo Torii, Prof Peter D. Lee

Scheduled presenter: Mr Akash Sivananthan · **Organisation:** University College London · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 202

DESCRIPTION OF PROPOSED TALK

Cardiovascular diseases are a leading cause of mortality worldwide, thus there is great interest in improving the outcomes of treating late-stage cardiac events such as myocardial infarction (MI). Clinical computational methods such as computation of fractional flow reserve based on CT and computational fluid mechanics (CFD) [1] utilise the strong link between the haemodynamics and flow distribution within atherosclerotic coronary arteries and their perfused myocardial territories, with the pathophysiology of MI to guide patient-specific interventional treatment.

Computational modelling of cardiac perfusion typically uses imaging modalities such as CT angiography (CTA) to reconstruct the flow domains needed to model coronary haemodynamics. However, the limited spatial resolution of routine clinical imaging techniques- around 500µm in CTA- restricts the reconstruction of the coronary lumen flow domain to the epicardial vessels and cannot capture vascular geometry at smaller scales such as the intramural vasculature and microcirculation within the myocardium [2]. Without this microstructural information, clinical image based CFD is restricted in the accuracy and types of boundary conditions applied which can lead to errors in the estimation of flow distribution across the coronary tree outlets and the associated myocardial region supplied and at-risk during MI [3]. High resolution imaging modalities such as µCT, that can capture vascular structures beyond clinical imaging resolution, are used in conjunction with clinical imaging to develop multiscale computational models that incorporate the hierarchical vascular organisation for more accurate estimation of myocardial perfusion [4].

In this study, ex vivo adult whole human heart imaging data at 16.25 µm resolution was collected using Hierarchical phase-contrast CT (HiP-CT) [5], a non-destructive synchrotron-based imaging technique that decouples resolution and field of view, used to develop a multiscale model of cardiac perfusion. The model consists of a 3D Navier-Stokes-based CFD model of the left and right coronary trees (with mean branch radii from 1500µm to 150µm), where the coronary outlets are coupled to 0D lumped parameter models tuned using the arteriole and microvascular geometry obtained via skeletonization [6] of the corresponding structures in the HiP-CT data.

Preliminary simulation results demonstrate the feasibility of applying CFD techniques to HiP-CT based coronary reconstruction, leveraging its superior spatial resolution to reconstruct complex coronary tree geometry and fine vasculature missed by standard clinical CT. This work serves as the first step in developing a HiP-CT based multiscale approach of cardiac perfusion to investigate the structure-function relationship between epicardial flow distribution and myocardial perfusion.

O18**Computational Modelling III: organ-scale biomechanics****Friday 4 September 2026** · 13:00-14:00 · Space Four**Chairs:** Professor Michael Sutcliffe · Mr YuChun Chou

Experimental and Computational Evaluation of Intraoperative Periprosthetic Fracture During Uncemented Total Hip Arthroplasty

Mr Vineet Seemala, Prof Mark Williams, Prof Richard King, Dr Arnab Palit

Scheduled presenter: Mr Vineet Seemala · **Organisation:** University of Warwick · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 226

DESCRIPTION OF PROPOSED TALK

Introduction

Intra-operative peri-prosthetic fracture (IOPPF) and aseptic loosening are major complications in uncemented total hip arthroplasty, accounting for nearly two-thirds of revision procedures. Current pre-surgical planning is largely based on geometric fit and provides limited insight into fracture risk or implant stability. To address this, a cadaveric study was conducted to quantify femoral fracture behaviour during uncemented THA and to support validation of computational IOPPF predictions.

Methods

A cadaveric study was performed using four human femoral specimens. Uncemented THA was carried out under surgical conditions, with sequential broach and implant insertion following standard practice. Motion capture was used to record three-dimensional insertion paths within the femoral canal. These paths were compared with predefined paths derived from femoral geometry. In three specimens, IOPPFs were intentionally induced by continued broaching beyond the clinically selected implant size. Fracture events were captured and characterised using medical CT and micro-CT imaging. Post-operative imaging combined with motion capture data enabled reconstruction of spatial and temporal conditions at fracture initiation. These events, including location and insertion depth, formed the primary validation reference. In the fourth specimen, an implant was inserted using standard surgical selection. A finite element analysis framework based on patient-specific femoral geometry and heterogeneous material properties was developed to simulate stepwise broaching and implantation along the measured paths [1]. The model extended previously developed work and was used to predict IOPPF risk and validate against experimental outcomes.

Results

Measured broach and implant trajectories showed strong agreement with defined paths, with axial translation dominating and minimal rotational deviation. IOPPFs were successfully induced in three specimens. CT and micro-CT confirmed consistent cortical failure patterns across samples. Fracture initiation correlated with broach insertion depth, providing a repeatable failure metric. The finite element model predicted fracture location, broach size, and insertion depth at failure with strong agreement to experimental results. It also correctly predicted no fracture in the fourth specimen, consistent with observations.

Conclusion

This study presents a cadaveric investigation of IOPPF during uncemented THA, combining motion capture and post-operative imaging to characterise fracture events and insertion mechanics. The integrated experimental and computational framework demonstrated strong agreement between predicted and observed outcomes, supporting improved risk assessment beyond conventional geometry-based planning.

O18**Computational Modelling III: organ-scale biomechanics****Friday 4 September 2026** · 13:00-14:00 · Space Four**Chairs:** Professor Michael Sutcliffe · Mr YuChun Chou

Computational modelling of thrombus formation in the left atrial appendage in atrial fibrillation

Miss Meiyi Zhou, Miss Anna Maria Lo Presti, Dr Matthew Lee, Dr Claire Argüello Martin, Professor Shervanthi Homer-Vanniasinkam, Professor Gaetano Burriesci, Dr Giorgia Maria Bosi

Scheduled presenter: Miss Meiyi Zhou · **Organisation:** University College London · **Programme slot:** 13:50-14:00 · **Order:** 6 · **Paper:** 235

DESCRIPTION OF PROPOSED TALK

Atrial fibrillation (AF) is a major risk factor for thromboembolic stroke, with the left atrial appendage (LAA) identified as the predominant site of thrombus formation in non-valvular AF due to flow stasis and recirculation [1]. Clinical risk scores, such as CHA₂DS₂-VASc, support risk stratification but do not directly account for patient-specific haemodynamics [1]. While imaging modalities can detect established thrombus, they offer limited insight into the underlying flow mechanisms driving thrombogenesis. Computational modelling provides a promising framework to bridge this gap by linking local haemodynamics with thrombus formation processes.

This study develops a computational method for modelling thrombus formation in the left atrium (LA) and LAA to support patient-specific thrombosis risk assessment under AF conditions. The model is based on a continuum computational fluid dynamics (CFD) approach, where blood flow is governed by the incompressible Navier-Stokes equations and thrombus formation is described using transport-reaction equations. The evolving thrombus is represented as a porous medium, enabling two-way coupling between clot growth and local flow through a permeability-based resistance term.

Thrombus formation is represented using nine factors related to the coagulation cascade and mainly controlled by haemodynamic indicators such as low shear rate and high residence time. These indicators identify thrombus-prone regions.

The model is first validated against backward-facing-step benchmark experiments [2], which provide a controlled separated-flow environment characterised by recirculation and low-shear regions. The model successfully reproduces experimentally observed thrombus initiation, growth patterns, and final morphology, with good quantitative agreement in thrombus volume and geometric characteristics for both bovine and human blood cases. These results demonstrate that the approach captures the key macroscopic features of haemodynamics-driven thrombosis in recirculating flows.

Building on this validation, the study extends the modelling framework toward patient-specific LAA applications. Cardiac computed tomography (CT) data are used to reconstruct one anatomically realistic LAA geometry, preserving key morphological features such as curvature, lobes and trabeculations, which are known to influence flow stasis and shear distribution [3]. A dedicated image-based workflow is developed for segmentation, surface processing, and mesh generation, providing the basis for future high-fidelity simulations [4]. Patient-specific simulations predict thrombus formation in a location and volume comparable to the corresponding CT dataset.

Overall, this work presents a haemodynamics-based framework for modelling thrombus formation in cardiovascular flow. By combining benchmark validation with patient-specific LAA modelling, it provides a basis for future investigations of AF-related thrombosis and supports the long-term development of personalised, mechanism-based risk assessment.

019**Biomaterials II: biofabrication and sustainable manufacture****Friday 4 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Hazel Screen · Dr Francesco Giorgi

Real-time label-free exploration of the dynamics and interactions of bacteriophages

Miss Grace Ritchie, Mr Francesco Giorgi, Mrs Jude Curran, Mr Eann Patterson

Scheduled presenter: Miss Grace Ritchie · **Organisation:** University of Liverpool · **Programme slot:** 13:00-13:10 · **Order:** 1 · **Paper:** 55

DESCRIPTION OF PROPOSED TALK

Introduction

Bacteriophages are vital in bacterial ecology and show promise for therapy and diagnostics amid rising antimicrobial resistance [1]. Understanding phage diffusion is key for developing effective treatments. Conventional methods like electron or fluorescence microscopy require invasive preparation, which can affect biological behaviour and hinder real-time observation [2,3]. This study introduces a novel, label-free caustics-based optical microscopy that uses manipulated light to enhance detection of nanometric phages [4]. The method allows real-time tracking of phages with minimal sample alteration and supports phage therapy and diagnostics research.

Materials and Methods

Four bacteriophages (E79, T4, Q β , M13) and a 100nm gold nanoparticle were tested across five media (LB, BHI, NB, PB, PBS). Morphology was confirmed by transmission electron microscopy (TEM). Phage caustics were created with an optical inverted microscope (Zeiss Axio Observer.Z1) with Kohler illumination and a 546 nm narrowband filter [4]. Diffusion coefficients (DCs) and convex hull areas (CHAs) were obtained using caustics microscopy and ImageJ analysis.

Discussion

and Conclusion

Media composition had little effect on phage diffusion and all phages displayed lower DCs than nanoparticles. This was likely due to differences in the size, shape and surface charges of phages and gold nanoparticles. Higher phage concentrations decreased DCs, suggesting increased inter-phage interactions. Despite slower diffusion, phages showed equal or greater spatial exploration compared to nanoparticles. Thus, diffusion rate does not restrict phage infection potential. Caustics microscopy proved effective for real-time, label-free phage tracking and offered new insights into phage dynamics in relevant environments.

O19**Biomaterials II: biofabrication and sustainable manufacture****Friday 4 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Hazel Screen · Dr Francesco Giorgi

Towards an Eco-Friendly Healthcare: The Role of Biodegradable Materials in Sustainable Medical Device Manufacturing

Dr Ella-Louise Handley, Prof Marc Desmulliez, Prof Duncan Hand, Dr Carolina Tacchella

Scheduled presenter: Dr Carolina Tacchella · **Organisation:** Heriot-watt University · **Programme slot:** 13:10-13:20 · **Order:** 2 · **Paper:** 56

DESCRIPTION OF PROPOSED TALK

Sustainability is an increasingly critical consideration in the design and manufacture of medical devices, as healthcare systems align with Environmental, Social, and Governance (ESG) strategies. A major challenge lies in the widespread reliance on single-use plastics, with only a small proportion currently being recycled [1]. In the UK, the NHS has committed to achieving net zero emissions by 2040, supported by initiatives such as the Plastics Reduction Pledge, highlighting the growing pressure to reduce dependence on disposable plastics [2]. While these materials remain essential for infection control and patient safety, there is an urgent need to identify alternatives that balance performance, biocompatibility, and environmental impact.

This project investigates the potential of polyhydroxybutyrate-co-valerate (PHBV), a biobased and biodegradable polymer, as a sustainable alternative for external, low-risk, single-use medical devices. In collaboration with Indenti Ltd. and Tily Blooms Ltd., two case studies were explored: the IDY™ interdental cleaning device and a home insemination syringe. Both products currently rely on non-biodegradable plastics, presenting an opportunity for significant environmental benefit.

Although PHBV has been widely studied for internal biomedical applications due to its favourable mechanical properties and biocompatibility, its suitability within regulated external device contexts remains unclear. This work aims to address this gap by generating baseline data on the processability, sterilisability, and shelf-life stability of PHBV.

Injection moulding, the predominant manufacturing method for disposable medical plastics, was used to produce test specimens. Sterilisation using hydrogen peroxide (H₂O₂) plasma preserved dimensional integrity, tensile properties, and surface roughness more effectively than steam sterilisation, which caused distortion due to elevated temperature and moisture. Accelerated ageing, conducted using a climate chamber to simulate real-life conditions, revealed increased brittleness and dimensional changes over time, which may compromise the performance of load-bearing components.

These findings provide early insight into the manufacturability and stability of injection-moulded PHBV for external medical devices. This study contributes to the evidence base needed to support the adoption of biodegradable materials within regulated medical device pathways.

O19**Biomaterials II: biofabrication and sustainable manufacture****Friday 4 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Hazel Screen · Dr Francesco Giorgi

Bioinspired Surface Engineering of Carbon Fibre Microelectrodes for Real-Time Neurotransmitter Detection

Mr Charlie Rayner

Scheduled presenter: Mr Charlie Rayner · **Organisation:** Imperial College London · **Programme slot:** 13:20-13:30 · **Order:** 3 · **Paper:** 90

DESCRIPTION OF PROPOSED TALK

Neuroinflammatory and neurodegenerative conditions affect approximately 15% of the global population [1], while histamine-mediated skin conditions impose a parallel burden; atopic dermatitis affects around 13% of children and 5% of adults, and the lifetime prevalence of urticaria approaches 20% [2]. Mast cell degranulation, releasing histamine and serotonin, is implicated across both contexts, yet the real-time neurochemical dynamics underlying these processes remain poorly characterised, in part due to a lack of analytical tools capable of resolving rapid signalling events in physiologically relevant tissue models.

Carbon fibre microelectrodes (CFMEs) coupled with fast-scan cyclic voltammetry (FSCV) offer sub-second temporal resolution of electroactive analytes, making them well-suited to capturing transient neurotransmitter release. However, discrimination against co-occurring electroactive interferents and stable integration with living tissue models remain significant analytical challenges for conventional CFMEs.

Drawing on the adhesive chemistry of marine mussel foot proteins [3], polydopamine (PDA) was deposited onto CFMEs via oxidative self-polymerisation under mild aqueous conditions, yielding a conformal bioinspired coating serving as a versatile scaffold for further functionalisation. Subsequent incorporation of extracellular matrix (ECM) components promoted cell adhesion directly at the electrode surface. PDA functionalisation yielded a significant improvement in selectivity against common electroactive interferents under FSCV conditions, with additional improvement to histamine and serotonin sensitivity.

This electrode platform has been applied to real-time electrochemical detection of serotonin and histamine release from stimulated mast cells, with planned application to brain and skin organoid models. These results demonstrate that bioinspired PDA-ECM surface engineering represents an effective strategy for developing selective, cell-compatible CFMEs for neurochemical sensing in complex biological systems.

O19**Biomaterials II: biofabrication and sustainable manufacture****Friday 4 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Hazel Screen · Dr Francesco Giorgi

Membranes Matter: Electrospun Materials for the Advancement of Lateral Flow Diagnostics

Miss Nicola Kelly, Dr Riaz Akhtar, Dr Lucy Bosworth, Dr Julia Behnsen, Dr Alex Ciupa, Dr Jenny Aveyard

Scheduled presenter: Miss Nicola Kelly · **Organisation:** University of Liverpool · **Programme slot:** 13:30-13:40 · **Order:** 4 · **Paper:** 29

DESCRIPTION OF PROPOSED TALK

First developed in the 1980s, lateral flow tests (LFTs) are membrane-based diagnostic devices that are simple to use, inexpensive, robust, and accessible. However, their true potential was not recognised until more recently during the COVID-19 pandemic, which saw LFTs used on an unprecedented scale globally, allowing diagnosis and monitoring to occur beyond healthcare settings¹. Despite this, LFTs are fraught with issues relating to sensitivity and selectivity.

Currently, nitrocellulose membranes are the industry standard due to their low cost, mechanical strength, and high protein binding capacity. However, nitrocellulose membranes also have shortfalls, such as sensitivity to environmental factors that affect their mechanical strength, highly flammable behaviour, and batch-to-batch variation due to the manufacturing method. By reconsidering the materials and production method, the membrane design could significantly change LFT performance.

Manufacturing techniques such as electrospinning allow the fabrication of nanofibrous polymer materials with high porosity, interconnected porous networks, and a high surface-to-volume ratio. The membrane's porosity governs the capillary flow of a sample/reagent through the LFT, which in turn governs the LFT's sensitivity.

The morphology of the commercial and electrospun membranes were characterised using SEM and MicroCT to calculate the porosity and pore size distribution, and surface area of the membranes, and compared to data acquired using BET. Protein binding was calculated both in static and dynamic form using UV-Vis and HPLC, respectively.

Electrospun membranes displayed fibre uniformity, increased pore interconnectivity, and variable porosities when analysed using MicroCT and BET analysis. Polymer one displayed an increase in surface area compared to polymer 2. Protein binding was characterised using HPLC which displayed an increase in protein binding range compared to commercial nitrocellulose.

This project facilitates a step change in materials and manufacturing techniques in LFT production by investigating the use of electrospinning to fabricate polymer membranes with superior properties that will improve the sensitivity and selectivity of membrane-based diagnostics. This approach has the potential to address existing challenges and further expand the application of LFTs in point-of-care testing.

019**Biomaterials II: biofabrication and sustainable manufacture****Friday 4 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Hazel Screen · Dr Francesco Giorgi

Calcium Vacancies in Hydroxyapatite: A Combined DFT and Experimental Study

Dr David Olubiyi Obada, Dr Simeon Akindele Abolade, Mr Shittu Babatunde Akinpelu, Dr Stefan Csaki, Dr Akinlolu Akande, Prof. Frederik Claeyssens, Prof. Gwendolen Reilly

Scheduled presenter: Dr David Olubiyi Obada · **Organisation:** University of Sheffield · **Programme slot:** 13:40-13:50 · **Order:** 5 · **Paper:** 157

DESCRIPTION OF PROPOSED TALK

Density functional theory (DFT) calculations combined with the DOPED defect-analysis framework were employed to investigate intrinsic calcium vacancies in hydroxyapatite (HAp) at the crystallographically distinct Ca(I) and Ca(II) sites, represented as VCa(I) and VCa(II), respectively. This study aims to correlate defect energetics with experimentally observable structural variations in HAp to better understand defect accommodation within the lattice. The calculated defect formation energies revealed only a small energy difference between vacancies at the Ca(I) and Ca(II) sites, suggesting weak site selectivity and the possible coexistence of both vacancy configurations under realistic synthesis conditions. These results indicate that calcium deficiency, commonly observed in biological apatite, can be structurally accommodated without significant lattice destabilization. To support the computational predictions, two calcium-deficient HAp models were synthesized and characterized using X-ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR). The experimental analyses suggest subtle structural distortions consistent with calcium vacancy formation in HAp. This combined computational-experimental approach helps to understand defect-tolerant behavior in HAp and supports defect engineering strategies for optimizing biomaterials for biomedical applications.

O19**Biomaterials II: biofabrication and sustainable manufacture****Friday 4 September 2026** · 13:00-14:00 · Space Five**Chairs:** Professor Hazel Screen · Dr Francesco Giorgi**Polyhydroxyalkanoate (PHA) / polyethylene glycol (PEG) blends for post-myocardial infarction (MI) repair**

Miss Aimee Van Domburg, Professor Ipsita Roy

Scheduled presenter: Miss Aimee Van Domburg · **Organisation:** University of Sheffield · **Programme slot:** 13:50-14:00 · **Order:** 6 · **Paper:** 12**DESCRIPTION OF PROPOSED TALK****INTRODUCTION**

Patients with MI are three times more likely to develop heart failure (HF) than matched controls as human cardiomyocytes (CMs) have limited regenerative potential, leading to the development of a tough fibrotic scar [1,2]. Delivering new CMs to the myocardium could encourage scar reversal, however, direct cell therapy via transplantation is largely ineffective as few cells are successfully grafted [3]. A cardiac patch could therefore be used as a cell carrier, providing a protective scaffolding which degrades in-situ to encourage migration onto the site of injury. Medium-chain-length PHAs (mcl-PHAs) have previously been indicated for this purpose [4]. Patches implanted in rodent MI models demonstrated excellent vascularisation and integration of endothelial cells (ECs), however, ex-vivo histological assessment showed limited CM grafting onto the heart despite their presence on the patch post-explant. Blending mcl-PHAs with a hydrophilic polymer, such as PEG, could increase degradation rate via encouragement of hydrolytic cleavage of mcl-PHA's ester bonds, thereby incentivizing CM migration.

METHODS

Mcl-PHA/PEG2000 blends were produced by combining both polymers under heated, stirring conditions in a solvent system comprising chloroform and dichloromethane. The blends were characterised extensively via light microscopy, FTIR, water contact angle (WCA), TGA, and DSC. A resazurin assay using a murine cardiomyoblast cell line (C2C12) was performed to assess direct and indirect viability. Degradation and swelling assays were conducted over a 28-day period in PBS and 25 U/ml pancreatic porcine lipase solution.

RESULTS

Multiple blends containing varying ratios of mcl-PHA and PEG2000 were reproducibly produced following optimisation. FTIR confirmed the presence of both compounds within the resulting blends. PEG2000 formed microparticles within an mcl-PHA matrix, as confirmed by light microscopy. The blends containing PEG2000 were significantly more hydrophilic than neat mcl-PHA. Mcl-PHA/PEG2000 blends had considerable swelling following incubation in PBS, showing water intake into the material. Mcl-PHA/PEG2000 blends also had an increased degradation rate compared with neat mcl-PHA, showing lower dry mass and molecular weight following incubation in lipase. Solvent-cast mcl-PHA/PEG2000 blends also had excellent biocompatibility with C2C12 cells compared with mcl-PHA and TCP controls. Finally, DSC and TGA indicated suitable thermal behaviour for melt-based processing, making this a promising material for additive manufacturing (AM) of complex cardiac patch geometries.

DISCUSSION & CONCLUSIONS

Successful combination of hydrophilic polymers with mcl-PHA has not previously been reported in literature. Mcl-PHA/PEG2000 blends had suitable thermal, degradation, and biological behaviour, making this a promising material for cardiac tissue engineering. Further processing via AM is needed.

O20**Assistive Technology and Diagnostic Innovation****Friday 4 September 2026** · 14:00-15:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Professor Anthony Bull

Quantifying residual diagnostic information beyond standard measurements in 12-lead ECGs

Mr Zhongli Wu, Prof Gregory Yoke Hong Lip, Mr Bilal H Kirmani, Prof Yalin Zheng

Scheduled presenter: Mr Zhongli Wu · **Organisation:** University of Liverpool · **Programme slot:** 14:00-14:10 · **Order:** 1 · **Paper:** 199

DESCRIPTION OF PROPOSED TALK

The 12-lead electrocardiogram (ECG) is interpreted clinically through standardised measurements, including intervals, amplitudes, axes, and rhythm descriptors, yet deep learning models trained on raw waveforms consistently outperform classifiers built on these measurements [1]. Whether this advantage reflects clinically meaningful morphology absent from standard measurements, or merely limitations of concept extraction and readout models, has not been quantified at the per-diagnosis level required to guide model deployment. Using the PTB-XL dataset (21,799 recordings, 23 diagnostic subclasses) [2], we constructed concept banks of progressively increasing dimensionality and trained per-class linear probes against a ResNet1D black-box reference. A linear probe on 25 NeuroKit2 signal-processing features captured 59.3% of black-box macro-AUPRC (0.256 vs 0.431); adding 22 rhythm and form descriptors raised this to 71.9%; 531 algorithmically extracted features from PTB-XL+ [3] reached 85.7%; and a 553-dimensional combined bank achieved 92.6%. The remaining 7.4% gap persisted when using a neural concept extractor that matched ground-truth concept probes within 1%, and when replacing logistic regression with gradient-boosted classifiers, which improved the 47D bank by only 0.9 percentage points. This points to a representational, rather than extraction or readout-capacity, limitation. Concept sufficiency was strongly heterogeneous across diagnoses: bundle branch blocks, hypertrophy, and normal rhythm were essentially saturated by 47 clinical concepts, matching or exceeding black-box performance, whereas Wolff-Parkinson-White syndrome (13%), incomplete left bundle branch block (14%), and lateral myocardial infarction (7%) showed strong residual dependence. Phase-masking analysis localised the residual to clinically plausible waveform regions: QRS morphology for bundle branch block (+0.803 macro-AUPRC drop) and P-wave morphology for atrioventricular block (+0.228 drop). The pattern replicated across four black-box architectures and on a population cohort of ~82,000 ECGs from UK Biobank [4]. Labels in this cohort were derived from automated device interpretations, providing a complementary rather than independently annotated validation.

These findings indicate that standard clinical ECG measurements explain most, but not all, diagnostic signal, leaving a small, stable reservoir of residual morphology beyond current expert feature vocabularies. The expansion-curve approach provides a per-diagnosis decision tool for choosing between transparent concept-based models and opaque end-to-end networks, and identifies the specific diagnoses for which extending the measurement vocabulary could help close the remaining gap.

O20**Assistive Technology and Diagnostic Innovation****Friday 4 September 2026** · 14:00-15:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Professor Anthony Bull

Collision Risk Assessment for Assisted Mobility with Sensor Fusion

Shanti Dewi Siawanta, Dr Lucas Fonseca

Scheduled presenter: Dr Lucas Fonseca · **Organisation:** University of Nottingham · **Programme slot:** 14:10-14:20 · **Order:** 2 · **Paper:** LB01

DESCRIPTION OF PROPOSED TALK

The ageing global population and the shift from passive walking aids to shared-control smart walkers demand safety mechanisms that are both robust and comfortable for older users in complex environments [1, 2]. Existing smart walker deployments rely on binary stop-go emergency braking [3], which can cause abrupt stops at approximately 10 cm from obstacles and increase the risk of instability or falls. This work introduces a context-aware, AI-enabled risk assessment system for smart walkers embedding sensor fusion [4] and trajectory prediction into assistive mobility control.

As a proof of concept, we used the Lean Empowering Assistant (LEA) robotic rollator [5]. The proposed architecture fuses data from rear-mounted LiDAR and front-mounted infrared (IR) sensors to mitigate LiDAR occlusion in LEA's forward 90° blind zone, while maintaining low power consumption and preserving user privacy. DBSCAN clustering with an IdentityKeeper logic provides consistent object segmentation and identity tracking, supporting explicit reasoning about dynamic obstacles such as walking individuals around the device. A Random Forest regression model, trained on spatial-temporal features extracted from LiDAR, IR and odometry, predicts object trajectories one second into the future, resulting in a prediction for collision risk estimation.

Risk is quantified by combining distance and closing velocity into a continuous score (0-100), which feeds into a directional warning logic and a dashboard graphical user interface that visualises hazard levels and sources in real time. Across dynamic experimental scenarios with both stationary and moving walker conditions, the system achieved precision and recall of 1.00 for detections within the <0.5 m high risk zone, and weighted F1-scores above 0.70, demonstrating reliable discrimination between imminent collisions, nearby non-threatening objects and those moving away. By transforming LEA's safety behaviour from binary braking to continuous, context-aware warnings, this work contributes to a practical, machine-learning-driven framework for safer shared control in assistive mobility, with direct relevance to clinical and community deployment of smart walkers for older adults.

O20**Assistive Technology and Diagnostic Innovation****Friday 4 September 2026** · 14:00-15:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Professor Anthony Bull

Bayesian and classical Machine Learning for robust remote gait analysis in Parkinson's Disease

Ms Dionysia Kasiani, Dr Antonella Macerollo, Dr Kristiaan D'Août, Dr Yifan Zhou

Scheduled presenter: Ms Dionysia Kasiani · **Organisation:** University of Liverpool · **Programme slot:** 14:20-14:30 · **Order:** 3 · **Paper:** LB05

DESCRIPTION OF PROPOSED TALK

Background

Remote gait assessment for people with Parkinson's disease (PwP) is an increasingly important approach for continuous symptom monitoring using wearable sensors. Multiple gait outcomes, including step length, temporal variability, gait speed, and freezing of gait (FOG) event, have been modelled using machine learning (ML). However, home-based data collection introduces challenges such as missing data, demographic imbalance, and signal noise, and existing modelling approaches differ substantially in how these factors are handled. This work investigates how classical ML models and Bayesian inference-based approaches perform across a range of gait parameter prediction tasks under differing data uncertainty conditions.

Methods

Wearable sensor data were used to predict multiple gait outcomes spanning spatial, temporal, variability-based, and event-based measures. Data were pre-processed under three conditions: (1) kernel filter imputation only; (2) kernel filter imputation combined with demographic weighting; and (3) the addition of synthetic noise to simulate home-like variability alongside kernel filter imputation and demographic weighting. Across all scenarios, multiple classical ML models were evaluated alongside their Bayesian inference counterparts using consistent cross-validation strategies. Gaussian Process Regression (GPR) was included as an additional Bayesian baseline. Model performance was assessed using Root Mean Square Error (RMSE) for continuous gait parameters, Intraclass Correlation Coefficient (ICC) to assess agreement with reference measures, and appropriate event-level metrics for FOG detection.

Results

Preliminary results indicate that Bayesian models, particularly Gaussian Process Regression, achieve lower RMSEs across several gait parameters compared with classical counterparts. Early findings suggest that Bayesian approaches may offer increased robustness to uncertainty arising from missing data and signal variability, with observable trade-offs in predictive performance across different gait outcomes and pre-processing configurations.

Conclusions

Early findings highlight the potential advantages of Bayesian inference for improving the reliability and robustness of remote gait outcome estimation in PwP, particularly under realistic home-based data conditions. By systematically evaluating multiple gait parameters, modelling paradigms, and data pre-processing scenarios, this work provides insight into performance trade-offs between classical and Bayesian ML approaches. Comprehensive validated results across all gait outcomes, models, and pre-processing conditions are currently under investigation, with final findings to be presented in September 2026. Future work will explore the integration of simulation-based and robotic gait models to generate controlled synthetic datasets, enabling further investigation of uncertainty-aware learning and robust model development for remote Parkinson's disease monitoring.

O20**Assistive Technology and Diagnostic Innovation****Friday 4 September 2026** · 14:00-15:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Professor Anthony Bull

The HEaRD Device - Hypoxic-impact Early Recognition and Detection

Ms Mahnoor Ali, Dr. Hannah Leese, Dr. Benjamin Metcalfe, Dr. Ela Chakkarapani, Prof. Naim Dahnoun

Scheduled presenter: Ms Mahnoor Ali · **Organisation:** University of Bath · **Programme slot:** 14:30-14:40 · **Order:** 4 · **Paper:** 47

DESCRIPTION OF PROPOSED TALK

Introduction

Fetal hypoxia is a lack of oxygen to the brain during labour, often leading to brain injury¹. Those affected can develop neurodevelopmental conditions such as cerebral palsy, epilepsy, and autism¹. It affects ~4 million babies annually and is responsible for 23% of global neonatal deaths². Amplitude integrated electroencephalography (aEEG) can be used to diagnose hypoxic brain injury post-birth but is not used during labour due to technological constraints. The aim of this project is to develop a device which can be used during labour to obtain fetal brain signals for continuous monitoring and earlier detection of hypoxic impact. To this end, the platform for this device uses microneedles because these are minimally invasive, causing little to no pain as they penetrate only the first layer of skin.

Materials and Methods:

This device, named HEaRD, is applied intravaginally during labour by a clinician onto the fetal scalp. Various mechanisms of device adhesion were explored; suction was chosen as the safer option for extended contact with delicate fetal scalp skin immersed in bodily fluids in an environment made hostile by periodic vaginal contractions and movement. Rapid prototyping via 3D printing facilitated design exploration and penetration studies on porcine skin are underway. Microneedles were made conductive via gold sputter coating. Properties of conductive microneedles were characterised such as electrical impedance at typical EEG frequencies and conductivity performance via cyclic voltammetry. A computational model was created to model the interaction of the electrodes with human skin. A participatory study to gather the views of clinicians on the design and usability of this device is also underway.

Results and Discussion

After multiple iterations, the HEaRD device design was finalised. The device is self-adhering once applied (as tested on gelatine and silicone+foam skin mimics). The usability of this device has been demonstrated successfully by a clinician on an obstetric mannequin. Computational modelling showed maximum current density at the microneedle-epidermis interface of 0.0095 A/m², which is insignificant. Experimentally, gold coated microneedles were tested on porcine skin covered with water and showed no signs of salt bridge formation. Gold electrodes were stable and conductive in wet conditions, experimentally.

Conclusions

The HEaRD device has the potential to transform fetal health monitoring to improve the care provided to both the mother and the baby, and ultimately, save lives.

O20**Assistive Technology and Diagnostic Innovation****Friday 4 September 2026** · 14:00-15:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Professor Anthony Bull

Smartphone-Based Nanozyme Immunosensor for Ultrasensitive Detection of Neurofilament Light Chain in Human Serum

Dr Ian Sandall, Dr Siew Suan Ng, Professor Hsin-Cheng Chiu, Professor Ruey-an Doong

Scheduled presenter: Dr Ian Sandall · **Organisation:** University of Liverpool · **Programme slot:** 14:40-14:50 · **Order:** 5 · **Paper:** 177

DESCRIPTION OF PROPOSED TALK

Neurofilament light chain (NfL) is an emerging biomarker for neurodegenerative disorders and neurological injury; however, its low abundance in serum presents significant analytical challenges for rapid and accessible diagnostics. This work presents a smartphone-compatible nanozyme immunosensor based on nitrogen-doped graphene quantum dot decorated mixed molybdenum oxides (MMO/N-GQDs) for ultrasensitive colorimetric detection of serum NfL. The MMO/N-GQDs nanocomposite was synthesised hydrothermally and functionalised with anti-NfL antibodies to create a peroxidase-mimicking sensing platform. The nanozyme catalysed the oxidation of tetramethylbenzidine in the presence of hydrogen peroxide, generating a measurable optical response detectable using both a laboratory UV-visible spectrophotometer and a smartphone-based RGB colour reader.

Kinetic analysis demonstrated strong peroxidase-like activity, with low Michaelis-Menten constants indicating high substrate affinity relative to conventional horseradish peroxidase. The developed immunosensor achieved a linear detection range of 16-1000 pg mL⁻¹ with a limit of detection of 2.24 pg mL⁻¹ using spectrophotometric analysis, while maintaining excellent selectivity against common serum interferents including ions, amino acids, cholesterol, and competing biomarkers. Recovery studies in human serum demonstrated recoveries between 83-104%, confirming suitability for clinically relevant samples.

The smartphone-based implementation enabled rapid and portable analysis with strong correlation to laboratory measurements, demonstrating potential for low-cost point-of-care neurological screening and remote diagnostics. The proposed nanozyme platform combines scalable fabrication, environmental robustness, and high analytical sensitivity, providing a promising route toward accessible biomedical sensing technologies for neurodegenerative disease monitoring.

O20**Assistive Technology and Diagnostic Innovation****Friday 4 September 2026** · 14:00-15:00 · Space One and Two**Chairs:** Professor Yalin Zheng · Professor Anthony Bull

Design of a low-cost, low-latency, PID-controlled heating module for cardiac troponin I assay development

Mr Oscar Weipers, Mr Alisdair Gordon, Dr Damion Corrigan, Dr Melanie Jimenez, Dr Alexandra Dobrea

Scheduled presenter: Mr Oscar Weipers · **Organisation:** University of Strathclyde · **Programme slot:** 14:50-15:00 · **Order:** 6 · **Paper:** LB08

DESCRIPTION OF PROPOSED TALK

Introduction

Cardiovascular disease remains the leading cause of death globally, commonly resulting in acute myocardial infarction (AMI). Diagnosing AMI relies on detecting elevated cardiac troponin I (cTnI) levels, but current hospital turn-around times often span several hours. Faster diagnosis can be achieved by deploying cTnI detection devices in a pre-hospital setting (e.g. ambulances), but current models have heavy accompanying analysers and high unit costs. Thus, further cTnI detection assay development is being conducted to expand the point-of-care device landscape. Laboratory incubators are frequently used to increase the sensitivity of cTnI detection by speeding up antigen-antibody binding kinetics. However, due to their high thermal latency, these devices may not be best-suited to assays with short incubation time frames. To address this limitation, a low-cost, low-latency heating module was developed to increase the sensitivity of cTnI detection assays.

Methods

The 3D-printed prototype module utilised a PID-controlled, conduction-based heating element to regulate the temperature of 96-well plate wells, using a custom thermistor probe for direct, in-liquid temperature measurement. A calibrated thermometer in a steady-state water bath was used to validate the accuracy of the thermistor probe and two 15-minute ramp-up incubation experiments were implemented to compare the thermal response of well samples in the prototype module and a standard laboratory incubator. Finally, two cTnI detection ELISAs of blood serum samples were conducted to compare the detection performance of both the prototype module and standard laboratory incubator.

Results and Discussion

Validation against a calibrated thermometer in a steady-state water bath demonstrated a probe accuracy of $\pm 0.3^{\circ}\text{C}$. 15-minute incubation ramp-up experiments illustrated the heating module's superior transient response, with its well samples reaching 37°C within the incubation time, which did not occur within the laboratory incubator. Moreover, the module displayed greater thermal uniformity, with no distinct thermal gradients present. cTnI detection ELISAs revealed a similar detection performance, both within a clinically relevant range. However, further repeats are required to confirm the heating module's effects.

Conclusion

In conclusion, the designed prototype heating module demonstrated a superior transient response, greater thermal uniformity, and a similar cTnI detection performance to a standard laboratory incubator, at a lower cost (<£50). It acts as a first step towards lowering the financial barrier to research areas requiring simultaneous heating and agitation of samples. Further work involves the integration of an active cooling system and a sample agitation method less susceptible to module mass, such as piezoelectric transducers.

021**Musculoskeletal Biomechanics II: bone, muscle and rehabilitation****Friday 4 September 2026** · 14:00-15:00 · Space Four**Chairs:** Professor Karl Bates · Dr Aron Syversen**Impact of ageing and footwear on the heel pad: ultrasound imaging of the macrolayer, microlayer and skin**

Mr Adam Rowlatt

Scheduled presenter: Mr Adam Rowlatt · **Organisation:** University of Liverpool · **Programme slot:** 14:00-14:10 · **Order:** 1 · **Paper:** 128**DESCRIPTION OF PROPOSED TALK**

The heel pad is a fibroelastic reticulated structure containing fat globules, allowing for impact absorption around the calcaneus. The structure of the heel pad comprises three main components: the macro-, microlayers and the skin (Maemichi et al., 2020). It is important to develop an understanding of these components contributing to the heel pad's ability to absorb shock. The total thickness of the heel pad has previously been shown to be 12.3 ± 2.9 mm when loaded and 19.8 ± 2.9 mm when unloaded by body weight (Balius et al., 2021). This study aims to investigate if there are age and footwear status-related changes within the macro, micro and skin layers of the heel pad.

187 participants were recruited to the study from Nkhoma Namibia (n=44), Southern Karnataka India (n=103), England (n= 26) and European minimal shoe wearers (n=14). An ultrasound scanner was used to provide all ultrasound images. Four approaches were repeated three times with two manually performed and two performed using a bespoke platform. The first approach had the smallest amount of force applied to yield a good image. The second approach required participants to maintain their position upon the box with a manual force applied. The remaining two measurements implemented a bespoke platform which held the ultrasound device stable and flush with the standing surface (Uzel et al., 2006). Heel pad distance was calculated from the coordinate data, providing distances for the macro, micro chamber and skin at rest, manual applied force, half and full body weight.

At rest, the UK population had a significantly thicker macro layer than the Indian, Namibian and minimal shoe wearers ($P<0.001$). There were no other differences within the macro across any of the other measurements. The micro layer was significantly ($P<0.05$) thinner within the Namibian population compared to the other three populations during half and full body weight loaded measures. However, there were no differences at rest. There were no differences between Namibian and Indian skin thickness. However, the UK was significantly lower than both the Namibian and Indian populations. When fully loaded, there were significant differences between the ages of 18-40 and 60+ years within the macro layer. There was no other significant difference with ageing seen within this study.

The Study has shown that the skin becomes significantly thicker within minimally shod and barefoot populations.

021**Musculoskeletal Biomechanics II: bone, muscle and rehabilitation****Friday 4 September 2026** · 14:00-15:00 · Space Four**Chairs:** Professor Karl Bates · Dr Aron Syversen**The role of soft tissue structures in the rotational stability of the distal tibiofibular (syndesmosis) joint.**

Mr Keir Robson, Professor Enrico Dall'Ara, Professor Claire Brockett

Scheduled presenter: Mr Keir Robson · **Organisation:** University of Sheffield · **Programme slot:** 14:10-14:20 · **Order:** 2 · **Paper:** 142**DESCRIPTION OF PROPOSED TALK****Background**

The ankle syndesmosis is a fibrous joint between the distal tibia and fibula. Previous ex vivo biomechanical studies have examined its rotational stiffness; however, considerable variation in sectioning protocols exists across studies. The effect of dissection of tissues surrounding the syndesmosis on rotational stiffness has not been comprehensively investigated.

Research Question: How do the tissue structures of the lower leg, ankle, and foot contribute to the passive rotational stability of the syndesmosis joint?

Methods

A novel sequential dissection study was undertaken to evaluate the contribution of soft tissues to the passive stability of the syndesmosis at the ankle. A full intact lower limb (tibial plateau) was mounted in an electromechanical testing machine (BOSE Electroforce 3510). Mechanical testing was undertaken under three loading conditions: 750 N axial load at 10 N/s; 20° external rotation at 0.5 Nm/s; and a combined loading scenario using the same parameters. The motion of the joint was evaluated using a (Qualysis) motion capture system by calculating the relative displacement of the fibula with respect to the tibia in all planes at each dissection stage and compared to the intact limb. The dissection stages consisted of proximal tibiofibular removal, forefoot ligament sectioning, soft tissue removal, lateral ligament sectioning, and deltoid ligament sectioning.

Results

Increased posterior displacement (1 - 2 mm) of the fibula relative to the tibia was observed following removal of the proximal tibiofibular joint. After soft tissue removal, lateral displacement increased (range: 1.6 - 1.9 mm), posterior displacement increased (range: 1.6 - 2.9 mm), and inferior displacement increased (range: 1.2 - 2.2 mm).

Conclusions

A reproducible experimental methodology was successfully developed to study the effect of sequential sectioning stages on the rotational stability of the syndesmosis. This was a preliminary study with $n = 1$; therefore, conclusions are limited at this stage, and additional specimens are required to generalise the findings. For this specimen, the proximal tibiofibular joint acted to constrain the fibula, particularly in the posterior plane. The soft tissues acted to constrain the movement of the fibula in all planes.

The results from this study contribute to the body of scientific knowledge regarding mechanical testing of the ankle syndesmosis and help to explain why certain discrepancies occur depending on the type of dissection protocol used.

021**Musculoskeletal Biomechanics II: bone, muscle and rehabilitation****Friday 4 September 2026** · 14:00-15:00 · Space Four**Chairs:** Professor Karl Bates · Dr Aron Syversen

Assessing the functional impacts of muscle ageing through high-fidelity predictive musculoskeletal simulations

Dr James Charles, Professor Karl Bates

Scheduled presenter: Dr James Charles · **Organisation:** University of Liverpool · **Programme slot:** 14:20-14:30 · **Order:** 3 · **Paper:** 152

DESCRIPTION OF PROPOSED TALK

Muscle ageing is linked to structural changes, including shorter muscle fibres, reduced muscle volume, and increased intramuscular fat, all contributing to lower force output. Even healthy ageing can lead to strength loss and reduced quality of life by increasing fall risk and susceptibility to lower limb injuries. However, the effects of healthy muscle ageing on the architecture of different lower limb muscles and their functional capabilities during dynamic movements remain poorly understood. Diffusion tensor imaging (DTI) offers an opportunity to quantify individual muscle architecture in vivo and has demonstrated significant differences in muscle structure between young and aged individuals [1]. When combined with predictive musculoskeletal modelling, these data allow for the investigation of the impacts of healthy ageing on whole-body and individual muscle functional performance.

10 healthily aged individuals (72.1 ± 4.61 years, 73.6 ± 11.1 kg) and 10 young individuals (27.2 ± 3.68 years, 71.4 ± 8.92 kg) were recruited for this study [1, 2]. The lower limbs of each individual were imaged using magnetic resonance and DT imaging to quantify individual muscle volumes, fibre architecture and phenotype. These data were used as inputs into scaled musculoskeletal models in Opensim [3], which were used to predict differences in joint kinematics, individual muscle dynamics and metabolic cost of transport (CoT) during gait across a range of gradually increasing walking speeds in young and aged individuals using MOCO [4].

Significant differences in muscle architecture and fibre phenotype were found between the age groups. There was also a greater degree of heterogeneity in the aged population, particularly in metrics related to fibre phenotype. Walking dynamics in the aged populations were characterised by lower hip range of motion, higher CoT and lower muscle efficiency at all speeds. In particular, the rectus femoris, a key knee extensor, showed a substantially lower degree of muscle efficiency in the aged individuals, which is directly related to CoT.

These results highlight the degree to which muscle architecture, fibre phenotypes and gait dynamics are impacted by ageing, with healthy ageing negatively impacting functional performance even during low-demand tasks such as walking. The knee extensor muscles are also identified as key potential targets for intervention regarding restoring function in aged individuals. Large-scale studies into the functional impacts of muscle ageing in various demographics using these methods have the potential to inform interventions which maintain mobility and quality of life in an increasingly ageing population.

021**Musculoskeletal Biomechanics II: bone, muscle and rehabilitation****Friday 4 September 2026** · 14:00-15:00 · Space Four**Chairs:** Professor Karl Bates · Dr Aron Syversen**Age-Related Evolution of Micromechanical Properties in the Cranium: Observing the Bone-Suture Interface using Nanoindentation**

Miss Charlotte Thompson, Dr Riaz Akhtar, Dr Roger Kissane

Scheduled presenter: Miss Charlotte Thompson · **Organisation:** University of Liverpool · **Programme slot:** 14:30-14:40 · **Order:** 4 · **Paper:** 48**DESCRIPTION OF PROPOSED TALK**

As global life expectancy rises, the elderly population faces a disproportionately high risk of traumatic brain injury (TBI) from minor falls. Understanding the mechanical evolution of the skull during senescence is vital for improving clinical outcomes and computational modelling. This study investigates how ageing affects the micromechanical properties of both cortical bone and fibrous sutures, which act as critical shock absorbers within the cranial vault. Characterising the specific properties and trends of sutures is essential for a more comprehensive understanding of their functional role within overall skull biomechanics.

Elastic modulus (E) and hardness (H) values were measured from 11 male Wistar rat skull samples from 4 different age groups: 2-, 6-, 18-, and 24-months. CSM (continuous stiffness measurement) nanoindentation was performed on these samples across two different sites: the frontal bone and the interfrontal suture.

Following nanoindentation, Oliver and Pharr analysis was used to convert load-displacement data into corresponding E and H values. Results revealed that the elastic modulus and hardness of both the bone and suture increased as a function of time. There was a nearly identical decrease in both E (95%) and H (96%) between the suture indent site and its adjacent bone indent site with age, displaying the proportional effect of mineralization-driven hardening as a result of ageing. Although the bone was generally much stiffer than the suture at all cohorts (for example, E at a 24-month sample was 17.5 GPa, compared to its corresponding suture E value of 4.9GPa), it was observed that both tissues followed a parallel maturation trajectory.

Spatial mapping was used to demonstrate the variation between mineralised, cortical bone and the flexible, compliant suture - highlighting the transitional zone between this hard-soft tissue interface. Results displayed a positive correlation between E and distance from the sutural interface: for example, at 500 μm from the suture, the bone reached a peak E of 19.6 GPa, compared to the bone 400 μm from the suture having an E of 16.5 GPa.

In conclusion, this study demonstrates a synchronized, age-dependent maturation of both cortical bone and sutural tissue in the murine cranium. Both the E and H of the tissues increased linearly with age, with higher variation in the development and senescence stages. The synchronised maturation emphasizes the need to move beyond treating the skull as a bulk material and consider localised structure and properties for a more accurate and precise understanding of its protective role.

021**Musculoskeletal Biomechanics II: bone, muscle and rehabilitation****Friday 4 September 2026** · 14:00-15:00 · Space Four**Chairs:** Professor Karl Bates · Dr Aron Syversen**Unravelling the mechanobiology of craniofacial system**

Prof Mehran Moazen, Dr Ce Liang, Dr Tengyang Qiu, Dr Damith Vithanage, Dr Marius Didziokas, Miss Miranda Steacy, Dr Katherine Rafferty, Prof Zi-Jun Liu, Prof Susan Herring, Dr Steve Twigg, Dr Ali Alazmani, Dr Erwin Pauws

Scheduled presenter: Prof Mehran Moazen · **Organisation:** University College London · **Programme slot:** 14:40-14:50 · **Order:** 5 · **Paper:** 191

DESCRIPTION OF PROPOSED TALK**Introduction**

Cranial joints facilitate brain growth during development and their premature fusion is a serious medical condition known as craniosynostosis. Using a mouse model (Crouzon) of this condition, we discovered that through external cyclic loading of the coronal suture in the dorsoventral direction (at 10gr inducing tension in this joint), we could delay its early fusion. The overall aim of this program of research was to (1) quantify the mechanical strain induced due to our in vivo loading regime in the mouse coronal suture (2) understand the molecular mechanisms by which our in vivo treatment could delay coronal suture fusion in mouse; (3) test the scalability of this approach in a larger animal model.

Methods

A custom code was developed based on digital volume correlation principals. It was used to analyze skull deformation and strain induced across the cranial coronal suture due to loading inside a micro-CT system before and after loading. Bulk RNA sequencing and spatial transcriptomic analysis were performed to investigate the biological effect of the treatment across the coronal suture in un/treated wild type and Crouzon mice. We also developed a new experimental system to replicate the mouse loading set-up in pig. We then carried out a series of in silico and ex vivo experiments on Yucatan mini-pig to determine various loading parameters for a subsequent in vivo loading experiment in this model (n=7).

Results

Von Mises strain in the range of 0.45-0.8 was measured across the coronal suture. As expected the treated side of coronal suture experienced a higher level of strain than the untreated side. Bulk RNA sequencing mapped a range of genes up and down regulated across all considered groups. For example, *Ddit4* was up-regulated due to loading in both wild type and Crouzon mice. In silico work enabled us to estimate the loading regime that could be used in the pig model. Our in vivo pig loading experiments were successfully completed highlighting the feasibility of this treatment in the larger animal model. Various characterization studies in the pig experiments are ongoing.

Discussion

This research has opened up the field of mechanobiology of the craniofacial system. Deciphering the molecular mechanisms and pathways that mechanical loading activates at the cellular level might identify molecular targets for the pharmaceutical treatment of craniosynostosis. At the same time pending the final outcome of the pig experiments, we may consider translation of a similar loading approach to patients.

021**Musculoskeletal Biomechanics II: bone, muscle and rehabilitation****Friday 4 September 2026** · 14:00-15:00 · Space Four**Chairs:** Professor Karl Bates · Dr Aron Syversen**A Combined In Vivo Dynamic Dual-Plane Fluoroscopy and Finite Element Modelling Approach for Human Knee Meniscal Kinematics**

Dr Rosti Readioff, Mr Raphael Surbeck, Dr Ariana Ortigas-Vásquez, Dr Seyyed Hamed Hosseini Nasab, Prof William R. Taylor

Scheduled presenter: Dr Yanhong Wang · **Organisation:** University of Liverpool · **Programme slot:** 14:50-15:00 · **Order:** 6 · **Paper:** 193**DESCRIPTION OF PROPOSED TALK**

Knee joint menisci are complex fibrocartilaginous structures located between the articulating surfaces of the femoral condyle and tibial plateau, where they provide essential load distribution and transmission functionality [1]. Previous studies have focused on in vitro investigations of knee joint mechanics, which restricts observation of meniscal behaviour in the natural physiological environment [2]. This study therefore aimed to investigate knee joint menisci kinematics during the stance phase of gait in vivo using experimental, imaging, and computational methods.

Following ethics approval, optical marker and force plate data, medical imaging, and dynamic dual-plane fluoroscopy were collected from a healthy participant. Photon-counting computed tomography and 7-tesla magnetic resonance images were used to develop a finite element (FE) model of the participant's right knee. Bones were segmented from computed tomography images, while the menisci, articular cartilage, and meniscal roots were segmented from magnetic resonance images. The segmented geometries were exported as FE models, with material properties for bones, articular cartilage, and menisci assigned according to previous descriptions [3]. Meniscal roots were modelled as continuum solid structures with linear elastic properties similar to the circumferential modulus of the menisci, while cruciate and collateral ligaments were modelled as ties [4].

Experimental gait data were used to define and validate FE model boundary and loading conditions. A parametric analysis comprising eight simulation cases was conducted to examine the influence of knee kinematics on meniscal mechanics during level walking stance, with varying boundary conditions and ground reaction loads. The most complex simulation applied three rotational kinematic profiles and an axial ground reaction load.

Peak resultant displacement was greater in the medial meniscus than the lateral meniscus at a midpoint along the superior edge, with the largest displacement observed at approximately 10% of the gait cycle in both menisci. However, displacement in other regions of the lateral meniscus was frequently greater during stance. The most complex simulation showed that the lateral meniscus displaced anterolaterally by up to 7.6 mm at approximately 20% of the gait cycle, whereas medial meniscus displacement was minimal, reaching up to 3.8 mm in the posterolateral direction.

These findings indicate that knee kinematics affect meniscal displacement more than axial loads alone, particularly during abduction/adduction and tibial rotation. Preventing meniscal injury should therefore prioritise knee kinematics over weight-bearing alone. Future research should investigate impact-loading scenarios.

022**UKSB - Biomaterials****Friday 4 September 2026** · 14:00-14:50 · Space Five**Chairs:** Professor Jude Curran · Dr Lucy Bosworth

Electrospun PCL/dECM Composite Scaffolds Derived from Porcine Carotid Artery for Small-Diameter Vascular Graft Applications

Dr BESHAI Alsaif, Prof James B. Phillips, Prof Duncan Q.M. Craig, Dr Maryam Parhizkar

Scheduled presenter: Dr Beshair Alsaif · **Organisation:** KACST · **Programme slot:** 14:00-14:10 · **Order:** 1 · **Paper:** 7

DESCRIPTION OF PROPOSED TALK

Small-diameter vascular grafts (SDVGs; ≤ 6 mm inner diameter) remain clinically challenging due to thrombosis, poor endothelialization, and low long-term patency. To address these limitations, electrospun composite scaffolds incorporating decellularized extracellular matrix (dECM) derived from porcine carotid artery were developed. This tissue source is rich in vascular-specific proteins such as collagen and elastin.

dECM was blended with poly(ϵ -caprolactone) (PCL) at 0.1, 0.25, and 0.5 wt% and electrospun using a chloroform/methanol solvent system to produce fibrous scaffolds with extracellular matrix-mimetic architecture. Scaffolds were characterized for morphology (SEM), chemical composition (FTIR), mechanical properties, hydrophilicity (water contact angle and uptake), and in vitro degradation. Biological performance was evaluated using human umbilical vein endothelial cells (HUVECs) and human dermal fibroblasts (HDFs) via metabolic activity assays, live/dead staining, and cytoskeletal (F-actin/nuclear) imaging.

Uniform nanofibrous structures were obtained, confirming successful dECM incorporation without compromising fiber morphology. dECM significantly enhanced hydrophilicity, modulated mechanical properties, and accelerated degradation in a concentration-dependent manner. All PCL/dECM scaffolds supported cell attachment and viability, with improved HUVEC attachment compared to pure PCL. Larger fiber diameters correlated with increased endothelial attachment, while HDF proliferation was highest at 0.5 wt% dECM.

These results demonstrate that tunable PCL/dECM electrospun scaffolds combine mechanical stability with biological functionality, offering a promising platform for bioactive small-diameter vascular grafts.

O22**UKSB - Biomaterials****Friday 4 September 2026** · 14:00-14:50 · Space Five**Chairs:** Professor Jude Curran · Dr Lucy Bosworth

Antimicrobial Efficacy and Elution Characteristics of Rifampicin-eluting PLGA Coatings for Medical Implants

Miss Sarah Eccles, Dr. Michelle Maclean, Dr. Sean McGinty, Dr. David W. Shields, Dr. Christopher McCormick

Scheduled presenter: Miss Sarah Eccles · **Organisation:** University of Strathclyde · **Programme slot:** 14:10-14:20 · **Order:** 2 · **Paper:** 230

DESCRIPTION OF PROPOSED TALK

Background

Medical device infection is a serious complication which can affect all types of implantable medical devices. Treatment is particularly challenging on fully-implanted devices such as orthopaedic or cardiac implants, where removal of the device may be required to eradicate infection. Biodegradable polymer coatings which elute antibiotics could be applied to the surface of fully-implanted devices for the prevention of bacterial infection, but optimisation of such coatings is critical to their success. Elution behaviour of drugs from the highly biocompatible, biodegradable polymer poly(lactic-co-glycolic acid) (PLGA) is dependent on many factors, including the lactide:glycolide (L:G) ratio of the PLGA, and drug loading.

Aim

s: To identify formulations of PLGA and rifampicin (a broad-spectrum antibiotic) with high efficacy against the bacterium *Staphylococcus aureus*, a common cause of medical device infection, and characterise their rifampicin release profiles.

Methods

Solutions of rifampicin and two different forms of PLGA (65:35 and 50:50 L:G) were mixed to create formulations with differing rifampicin concentrations (0.1%-50%). These solutions were applied to small medical grade stainless steel samples by dip-coating. Efficacy of all formulations against *S. aureus* was characterised initially by a modified disc diffusion method. This was followed by an assay to determine the ability of the coated materials to resist biofilm formation, where samples were incubated in 10^3 CFU/ml *S. aureus* suspension overnight and any biofilm subsequently recovered and quantified by sonication and standard microbiological plating. Rifampicin elution up to 12-20 weeks from selected coating formulations was measured with UV-vis spectrophotometry (350nm).

Results

Both 65:35 and 50:50 L:G PLGA coatings containing as little as 1% rifampicin produced zones of inhibition in the modified disc diffusion assays, demonstrating efficacy against *S. aureus* even at very low drug loading. Complete biofilm inhibition was achieved with higher rifampicin loaded coatings of both L:G ratios, showing efficacy against this more complex, clinically relevant bacterial challenge. Elution measurements performed on the most effective formulations demonstrated that decreasing rifampicin loading of the coatings slowed its release. Additionally, altering L:G ratio had minimal effects on the 50% and 40% rifampicin coatings, but significantly altered the elution profile of 25% rifampicin coatings.

Conclusion

These findings demonstrate the suitability of the 50%, 40% and 25% rifampicin formulations for potential use as medical device coatings. Next steps include investigating efficacy against other relevant pathogens, and effects of the coatings on mammalian cells.

O22**UKSB - Biomaterials****Friday 4 September 2026** · 14:00-14:50 · Space Five**Chairs:** Professor Jude Curran · Dr Lucy Bosworth

Green-Synthesized Silver Nanoparticle-Loaded Electrospun Fibres for Advanced Antimicrobial Wound Healing

Miss Adila Adila, Jenny Aveyard, Raechelle D'Sa

Scheduled presenter: Miss Adila Adila · **Organisation:** University of Liverpool · **Programme slot:** 14:20-14:30 · **Order:** 3 · **Paper:** 115

DESCRIPTION OF PROPOSED TALK

Introduction

Diabetic foot ulcers (DFUs) present a critical global health burden, with 5-year mortality rates estimated at approximately 50%, a figure that rivals or exceeds the mortality rates of many aggressive cancers. Managing these wounds is complicated by the rising prevalence of multi-drug resistant bacterial infections, significantly impairing their healing and limiting the efficacy of conventional treatments. Consequently, there is an urgent need for advanced localized antimicrobial strategies. Electrospun PEO: Alginate fibres offer a highly promising platform for the integration and delivery of antimicrobial silver nanoparticles (AgNPs). Importantly, the use of green chemistry approaches for AgNP synthesis, employing benign reducing agents, and aqueous systems, enhances biocompatibility while minimizing environmental and toxicological concerns. Their high surface-area-to-volume ratio and interconnected porosity mimic the natural extracellular matrix (ECM) to create an environment conducive to promote healing. This biomimetic structure also facilitates optimal gas exchange, effective exudate management, and the localized, sustained release of silver ions directly to the infected wound bed.

Materials and Methods:

AgNPs were synthesized via a green chemistry approach using the flavonoid Luteolin as a reducing and capping agent. The synthesis was optimized across a range of parameters: Luteolin concentration, pH, temperature, stirring speed, and incubation time. Characterization was performed via UV-Vis spectroscopy, DLS, and SEM. Electrospun PEO: Alginate blends (70:30, 50:50 and 30:70) nanofibers were optimized by varying the flow rate, applied voltage, tip-to-collector distance, and relative humidity. Antimicrobial efficacy was evaluated using *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

Results and Discussion

Optimal AgNP formation (mean size ~35 nm, PDI 0.184) was achieved at pH 10.3 and 50°C. For the polymer scaffolds, a flow rate of 1 mL/h at 22 kV produced the uniform, bead-free fibres with high reproducibility. Characterization confirmed successful loading of AgNPs within the fibres. Antimicrobial assays demonstrated that the AgNP-embedded scaffolds were effective at reducing the microbial burden of common wound pathogens. Future work will focus on investigating the long-term silver release kinetics and evaluating the in vitro biocompatibility.

022**UKSB - Biomaterials****Friday 4 September 2026** · 14:00-14:50 · Space Five**Chairs:** Professor Jude Curran · Dr Lucy Bosworth

Chondrogenesis of Y201 mesenchymal stem cells on PGS-M polyHIPE scaffolds

Miss Natasha Cheung, Professor Gwendolen Reilly, Professor Frederik Claeyssens, Professor Claire Brockett

Scheduled presenter: Miss Natasha Cheung · **Organisation:** University of Sheffield · **Programme slot:** 14:30-14:40 · **Order:** 4 · **Paper:** 175

DESCRIPTION OF PROPOSED TALK

Osteoarthritis (OA) is a degenerative disease that leads to joint dysfunction, pain and a decrease in quality of life. In the ankle, OA is rarely idiopathic and predominantly occurs after injury to the articular surface, forming an osteochondral defect (OCD) which initiates deterioration of the osteochondral unit ultimately leading to OA. Consequently, ankle OA typically affects younger and more active patients. Current methods of treating ankle OCDs and OA demonstrate limited success, particularly in long term outcomes which are essential for a younger patient demographic. As such, there is a need for an early intervention that can facilitate cartilage regeneration of OCDs and prevent further development towards OA.

An investigation of the capability of methacrylated poly(glycerol) sebacate (PGS-M) 3D scaffolds to facilitate the proliferation and differentiation of immortalised mesenchymal stem cells (hMSCs) toward a chondrogenic lineage was undertaken. PGS-M polymerised high internal phase emulsion (polyHIPE) scaffolds were synthesized via an emulsion templating technique. A water-in-polymer emulsion was formed and subsequently UV cured, creating a porous 3D scaffold for cell culture. The immortalised Y201 hMSC cell line was then cultured on these scaffolds in chondrogenic culture media containing 10ng/mL TGF- β 1 for 28 days alongside an undifferentiated condition cultured in standard culture media. Measurements were taken at four time points and proteoglycan production was examined using Alcian blue staining.

After staining it was found that the presence of proteoglycans was significantly higher in the differentiated scaffolds indicating that cells were able to differentiate and follow a chondrogenic lineage. Moreover, there was also a significant difference between each time point demonstrating that PGS-M scaffolds are able to support the proliferation of cells over time. These results indicate that PGS-M scaffolds are able to support both the growth of immortalised hMSCs and differentiation towards a chondrogenic lineage which is crucial for cartilage regeneration applications. Further work will include establishing whether bilayer PGS-M scaffolds can support the growth and differentiation of cells towards an osteogenic lineage whilst maintaining chondrogenic differentiation within a cartilage layer.

O22**UKSB - Biomaterials****Friday 4 September 2026** · 14:00-14:50 · Space Five**Chairs:** Professor Jude Curran · Dr Lucy Bosworth

3D-bioprinted biofilms towards advanced infection models and inactivation strategies: a protocol optimisation study

Dr Lisa Asciak, Dr Lucy Sinclair, Dr Michelle Maclean, Prof Wenmiao Shu

Scheduled presenter: Dr Lisa Asciak · **Organisation:** University of Strathclyde · **Programme slot:** 14:40-14:50 · **Order:** 5 · **Paper:** 219

DESCRIPTION OF PROPOSED TALK

Biofilms, microbial communities embedded within a self-produced polymeric matrix, are responsible for ~80% of chronic infections and are highly resistant to standard antimicrobial treatments[1]. Biofilm research often relies on 2D culture that lacks physiological complexity, or on animal models, which are ethically concerning and expensive[2]. Biofabrication advancements have sought to bridge this gap via 3D in vitro models, with 3D-bioprinting emerging as a powerful tool for rapidly fabricating complex, high-resolution, spatially-controlled bacteria-laden hydrogel constructs[3]. However, this field remains in its early stages, with characterisation largely relying on imaging analysis. Here, we use light-based 3D-bioprinting to fabricate bacterial hydrogel constructs with the aim of optimising bacterial recovery methods for quantifiable colony-forming units (CFU) measurements, towards improved 3D in vitro biofilm infection modelling.

Using *Staphylococcus aureus* as our model organism, we 3D-bioprinted lattice-like constructs using a combination of polyethylene glycol diacrylate (PEGDA) and alginate. This work involved four 14-day experimental studies investigating: (1) the optimal bacterial recovery method using sonication, stomaching (a paddle blender), or both, to subsequently investigate the impact of (2) seeding density (10^8 , 10^6 , 10^4 , 10^2 CFU/ml), (3) surrounding media (phosphate buffered saline (PBS) vs nutrient broth (NB)), and (4) hydrogel formulation (PEGDA, PEGDA:alginate, PEGDA:gelatine) on bacterial viability and growth kinetics. These hydrogels were then used as biofilm mimics for antimicrobial susceptibility testing (AST) at varying antibiotic concentrations (0.1, 1, 10 mg/ml) on days 0 and 1.

Across studies 1-4, bacterial counts were lowest at day 0 (likely due to 3D-printing stress), peaked on day 1 ($\sim 10^8$ CFU/gel) and plateaued ($\sim 10^7$ - 10^6 CFU/gel) until day 14. We identified: (1) sonication plus stomaching as the optimal bacterial recovery strategy owing to the high number of viable bacteria observed at day 1, (2) 10^6 CFU/ml as the seeding density that was high enough to provide consistent bacterial counts at day 0 but low enough to provide adequate capacity for growth from day 0 onwards, (3) NB as the incubation medium given the significant growth observed compared to PBS, and (4) no impact on bacterial growth from changes to hydrogel composition. AST showed complete inhibition at day 0 at 10 mg/ml and $\geq 99\%$ reduction at lower concentrations, while day 1 treatment, when bacterial counts peak, still achieved $\geq 97.7\%$ reduction across all concentrations.

This work presents an alternative protocol for quantifying bacterial viability within 3D-bioprinted hydrogels, which can be used alongside other characterisation methods to systematically investigate bacterial growth in 3D in vitro environments.

023**Clinical Diagnostics and Point-of-Care Systems****Friday 4 September 2026** · 15:20-16:20 · Space One and Two**Chairs:** Dr Ian Sandall · Dr Yanhong Wang

Rapid isolation of bacteria from positive blood cultures for bacteraemia diagnosis

Mr Daniel Nathan Tomas Cancado, Dr Daniel Spencer, Prof. Hywel Morgan

Scheduled presenter: Mr Daniel Nathan Tomas Cancado · **Organisation:** University of Southampton · **Programme slot:** 15:20-15:30 · **Order:** 1 · **Paper:** 36

DESCRIPTION OF PROPOSED TALK

Rapid antimicrobial resistance testing of bacteria is required to optimise therapy for bloodstream infections such as bacteraemia that can lead to sepsis, an illness that is the cause of millions of deaths globally. Current antimicrobial susceptibility tests (AST) are time-consuming, taking on average 2-3 days to deliver results. Rapid ASTs are important if the most appropriate antibiotics are to be prescribed quickly. We have developed a fast impedance-based AST platform (iFAST) that determines the resistance/susceptibility profile of bacteria from their electrical properties in 3 hours. However, isolating and concentrating the infectious agents from blood without compromising their viability remains a technically demanding challenge. Current rapid bacterial extraction methods such as blood lysis and centrifugation protocols are not compatible with rapid (~2 h) growth-based ASTs due to the use of harsh chemicals such as ionic detergents, which are used to lyse and remove the red blood cells. We have developed methods for isolating bacteria from infected blood samples using a combination of chemical and physical techniques. Five different sample isolation workflows were evaluated to determine bacterial viability and sample purity. Cell-friendly methods include the use of non-ionic detergents for the removal of the red blood cells whilst concentrating the viable bacteria. Gram-positive organisms are more susceptible to detergents than Gram negative. Saponin extraction methods have minimal impact on Gram positive growth and can be used for rapid impedance-based antimicrobial susceptibility.

023**Clinical Diagnostics and Point-of-Care Systems****Friday 4 September 2026** · 15:20-16:20 · Space One and Two**Chairs:** Dr Ian Sandall · Dr Yanhong Wang

Validating a Turn Detection Algorithm for a Wrist Worn Device in People with Parkinson's Disease

Miss Claire Wilkinson, Dr Kirsty Scott, Mr Phillip Brown, Professor Alison Yarnell, Professor Lynn Rochester, Dr Silvia Del Din, Dr Lisa Alcock

Scheduled presenter: Miss Claire Wilkinson · **Organisation:** Newcastle University · **Programme slot:** 15:30-15:40 · **Order:** 2 · **Paper:** 77

DESCRIPTION OF PROPOSED TALK

Turning is a complex full-body movement, which can be especially challenging for people with Parkinson's disease (PD) due to a variety of motor symptoms[1]. Conventionally, wearable devices (inertial measurement units (IMUs)) adhered to the lower back are used to evaluate turning[2]. Wrist-worn devices are perceived as more convenient and utilise existing smartwatch platforms however turning algorithms have only been validated for back-worn devices[3]. The aim of this study was to validate a turning algorithm for use with a wrist-worn device compared to the gold standard lower back device.

Data were analysed from the Mobilise-D Technical Validation Study[4]. 20 people with PD (mean age 69.8, MDS-UPDRS III 28.35) completed an L-test protocol in the lab (participants stand from a seated position, walk to a cone 4-m ahead, make a 90° left turn, walk 2-m, make a 180° left turn, walk 2-m, make a 90° right turn and return to the chair) while wearing an IMU on the non-dominant wrist and lower back (INDIP, triaxial accelerometer and gyroscope; 100Hz). The triaxial acceleration and gyroscope signals were fused using a Kalman filter to optimise the existing algorithm[3]. The zero crossings from the gyroscope signal were used to identify turns using the following thresholds: $\geq 45^\circ$ and 1.5-10.0s in duration. For each turn detected the turn angle, duration and angular velocity were calculated. Statistical differences between turn outcomes derived from the lower back and wrist IMUs were compared using a Mann Whitney U test.

Across the 20 participants, the lower back device detected a total of 60 turns compared to the wrist, which detected 75 turns. 59/60 lower back turns matched with 59/75 wrist turns. Of the additional turns detected by the wrist (n=15): 6 were turns not part of the L-test protocol (i.e. isolated hand movements) and 9 were 'partial turns' segmented due to hesitations detected by the algorithm (i.e. 1 back turn ~ 2 wrist turns). There was one turn detected by the back and not the wrist. Turn angle, duration and angular velocity calculated for the wrist and back device were not significantly different.

Our findings demonstrate the turning algorithm developed for a back device can successfully be adapted for use with wrist worn devices. Despite differences in the number of turns identified, device location had no impact on the outcomes calculated. Future analysis will explore different thresholds and filtering techniques to reduce isolated hand movements being detected as turns.

023**Clinical Diagnostics and Point-of-Care Systems****Friday 4 September 2026** · 15:20-16:20 · Space One and Two**Chairs:** Dr Ian Sandall · Dr Yanhong Wang

Reactive Inkjet-Printed Arrays for Early Detection of Cancer

Miss Leo Fish, Dr Stephen Brown, Dr David Alexander Gregory

Scheduled presenter: Miss Leo Fish · **Organisation:** University of Sheffield · **Programme slot:** 15:40-15:50 · **Order:** 3 · **Paper:** 80

DESCRIPTION OF PROPOSED TALK

Cancer poses a significant burden on the NHS with 346,217 new diagnoses in 2022¹. Furthermore, COVID-19 disruptions negatively impacted cancer waiting time targets¹. Diagnostic delays and late-stage presentation remain persistent challenges², with skin cancer services experiencing a 2.6-fold increase in urgent referrals between 2013 and 2022, placing substantial strain on diagnostic capacity³. Consequently, new technologies are needed to improve screening and reduce waiting times.

Circulating tumour cells (CTCs) offer a transformative liquid biopsy approach, enabling minimally invasive early detection and real-time disease monitoring⁴. CTCs reveal tumour heterogeneity and therapeutic resistance⁴, allowing comprehensive single-cell analysis⁵. Combined with other biomarkers, CTC-based approaches support early detection and personalised treatment strategies, helping to reduce diagnostic delays and healthcare bottlenecks⁴.

CTCs indicate metastatic risk across multiple cancer types; their presence correlates strongly with poor clinical outcomes⁵. The proposed scalable platform addresses critical limitations in current CTC technology. Existing FDA-approved systems such as CellSearch require specialised microfluidic infrastructure with limited throughput⁸. Our approach offers reduced manufacturing costs via automated reactive inkjet (RIJ) fabrication, improved accessibility for clinics/hospitals lacking specialised microfluidic systems, multiplexed detection of diverse CTC phenotypes (e.g. EpCAM+, TROP2+, PD-L1+) for comprehensive tumour profiling⁶; reduced sample volume requirements⁶.

We present a novel RIJ microarray platform integrated onto regenerated silk fibroin substrates, functionalised with antibodies for label-free, CTC capture sensors. The device integrates three complementary technologies: precision reactive inkjet printing for high-resolution, programmable antibody patterning with minimal reagent consumption; covalent immobilisation chemistry for robust antibody attachment onto silk scaffolds⁹; and immunoaffinity-based CTC enrichment leveraging the natural affinity between antibodies and CTC surface markers. This combination overcomes critical limitations of conventional CTC detection platforms by achieving simultaneous high-resolution and multiplexed detection while maintaining proper antibody orientation, a key factor enhancing antigen-binding efficiency.

Preliminary validation using fluorescently labelled functionalised polystyrene beads demonstrated successful particle capture on the functionalised silk sensor surfaces. Circulating tumour cells were simulated using EpCAM-expressing and non-expressing cell lines, where the sensing platform selectively captured EpCAM-positive HCT116 cells while showing minimal interaction with non-expressing cells, demonstrating the specificity and functionality of the sensor platform. CTC enumeration has the potential to serve as a critical prognostic biomarker, directly guiding treatment decisions and predicting therapeutic response⁶.

This work demonstrates the potential of reactive inkjet-printed silk microarrays as scalable and accessible platforms for multiplexed CTC detection, with applications in early cancer diagnosis, prognostic monitoring, and personalised medicine.

023**Clinical Diagnostics and Point-of-Care Systems****Friday 4 September 2026** · 15:20-16:20 · Space One and Two**Chairs:** Dr Ian Sandall · Dr Yanhong Wang

Differences in wearable-sensor-extracted digital mobility outcomes between adults with cerebral palsy and healthy adults.

Dr John Mitchell, Dr Francesca D'Andrea, Dr Ben Heller, Ms Kay Allan, Dr Tecla Bonci, Prof Vitaveska Lanfranchi, Prof Siva Nair, Dr Ellen Buckley

Scheduled presenter: Dr John Mitchell · **Organisation:** University of Sheffield · **Programme slot:** 15:50-16:00 · **Order:** 4 · **Paper:** 106

DESCRIPTION OF PROPOSED TALK

Introduction

Many adults with cerebral palsy (AwCP), experience gait decline despite a static underlying pathology [1]. Digital health technologies have potential to address healthcare gaps, by providing an objective measure of functional changes and enabling self-monitoring and early intervention [2].

A validated, single-sensor, lower-back approach, paired with an open-source pipeline (MobGap [3]), to enable remote mobility monitoring in real-world settings, was recently validated in five mobility-limiting conditions [4,5]. This study presents (i) a preliminary MobGap validation in AwCP, (ii) real-world gait differences in AwCP compared to healthy adults (HA).

Methods

Seven ambulatory AwCP (age 34.8 ± 8.6 , six male, GMFCS I-III) have been recruited (MoStrAct study, REC 19/YH/0221). They performed several straight and curvilinear walking tasks while wearing a lumbar-positioned inertial movement sensor (Axivity AX6, IMUs) and 15 reflective markers on the feet, lumbar, and wrist. From motion capture, ground-truth gait parameters were derived [6] and mean absolute error (MAE) of the IMU-derived walking speed calculated [3].

A 7-10 day real-world digital mobility assessment was completed using the AX6 with outcomes to determine behavioural and mechanical differences in walking compared to twenty HA (age 71.7 ± 5.6 , 11 male) [7].

Results

& Discussion

For lab-based walking speed, in AwCP, system agreement was reasonable (MAE: 0.19 m/s; LoA: -0.06, 0.44), yet slightly lower than other neurological conditions such as Parkinson's disease (MAE: 0.11; LoA: 0.01, 0.33) [5].

For the real-world monitoring, compared with HA, AwCP walked significantly less (78.36 ± 59.41 vs 109.41 ± 56.25 min/day) ($t = -3.3$, $p < 0.01$), with significantly reduced walking speed in walking bouts of >30 s duration (0.72 ± 0.12 vs 0.90 ± 0.12 m/s) ($t = -5.2$, $p < 0.01$) and shorter stride length (0.97 ± 0.12 m vs 1.1 ± 0.12 m) ($t = -4.2$, $p < 0.01$). We were unable to age-match these populations which may confound this comparison.

Conclusion

MobGap is capable of calculating accurate digital mobility outcomes from AwCP. This enables free-living gait analysis using lower-back wearable sensors to capture a meaningful picture of health for AwCP with reduced burden compared with current gait analysis methods.

Future work aims to increase the sample size, and explore the effect of GMFCS rating on algorithm performance, and clinical adoption of these methods.

Acknowledgments

This research is supported by the National Institute for Health and Care Research (NIHR) Sheffield Biomedical Research Centre (BRC) and the UKRI EPSRC South Yorkshire Digital Health Hub.

023**Clinical Diagnostics and Point-of-Care Systems****Friday 4 September 2026** · 15:20-16:20 · Space One and Two**Chairs:** Dr Ian Sandall · Dr Yanhong Wang

Developing Accessible, Inclusive Digital Surveys to Evaluate Training Outcomes

Mr Muhammad Faizan Basil, Mr. Sai Kumar Mattireddy, Dr. Zoe Morgan, Dr. Traolach Brugha, Dr. Himanshu Kaul, Dr. Samuel Tromans

Scheduled presenter: Mr Muhammad Faizan Basil · **Organisation:** University of Leicester · **Programme slot:** 16:00-16:10 · **Order:** 5 · **Paper:** 194

DESCRIPTION OF PROPOSED TALK

People with learning disabilities and autistic people experience significant health inequalities, partly attributable to gaps in professional training. Existing approaches to evaluating training outcomes have predominantly relied on generic online surveys or self-reported paper-based questionnaires, which often lack accessibility adaptations, exclude people with lived experience, and fail to capture diverse stakeholder perspectives. This study aimed to develop and validate accessible digital survey tools to evaluate the implementation and impact of learning disability and autism training for people with learning disabilities, autistic people, and health and social care professionals across England.

Surveys were developed using a prototyping model approach with the Django web framework, where HTML and CSS were utilised for accessibility-focused design including easy-read formatting, appropriate font sizing, and colour differentiation. JavaScript was implemented to enable interactive features such as draggable sliders, auto-progression upon answer selection, and conditional logic that dynamically adapted question pathways based on prior responses. Python was then used for data storage and manipulation. The surveys were built to be fully responsive across all screen sizes, devices, and browsers, ensuring equitable access for all participant groups. To balance survey length with breadth of evaluation, permuted block randomisation was implemented, whereby the same survey link dynamically assigned participants to different validated questionnaire modules, broadening evaluative scope without increasing individual burden. Strict privacy and cybersecurity protocols were implemented, ensuring secure data storage and compliance with GDPR requirements. Collected data was made available to stakeholders for statistical analysis. Survey content and design were developed iteratively in collaboration with clinicians, psychologists, people with learning disabilities, and health and social care workers across multiple feedback cycles, with each iteration refining wording, layout, and clinical appropriateness.

Several challenges were encountered during development. Existing survey tools lacked standardisation across stakeholder groups, and the length of validated questionnaire modules risked participant disengagement. Compatibility with outdated browsers presented technical barriers, and ensuring frictionless data output suitable for direct statistical analysis required deliberate architectural decisions. To address disengagement, conventional scrollable formats were replaced with single-question screens with smooth transitions and auto-progression upon answer selection, minimising clicks and maintaining participant focus. Full responsiveness across all screen sizes, devices, and browsers including legacy browsers was engineered to maximise accessibility. Data was structured and exported in formats ready for direct stakeholder analysis, eliminating post-collection processing overhead. These solutions produced an accessible, standardised, and technically robust suite of survey tools validated positively through PPIE engagement across all stakeholder groups.

023**Clinical Diagnostics and Point-of-Care Systems****Friday 4 September 2026** · 15:20-16:20 · Space One and Two**Chairs:** Dr Ian Sandall · Dr Yanhong Wang

Automated seizure detection using wearable devices: updated systematic review and meta-analysis of tonic-clonic and focal seizure detection

Miss Sumeya Mohamed, Muhammad Farooq Shaikh, Dr Davide Piaggio

Scheduled presenter: Miss Sumeya Mohamed · **Organisation:** University of Warwick · **Programme slot:** 16:10-16:20 · **Order:** 6 · **Paper:** 211

DESCRIPTION OF PROPOSED TALK

Wearable seizure detection devices offer a promising approach for continuous, non-invasive monitoring of epilepsy outside hospital settings. This systematic review and meta-analysis of literature on wearables for seizure detection was performed up to July 15, 2025, to update the previous work by Naganur et al., which was conducted to include studies up to November 10, 2021.

The studies were selected based on the inclusion criteria that the studies employed video-electroencephalographic (video-EEG) monitoring as the gold standard and gave sensitivity and false alarm rate (FAR) when measuring wearable seizure detection devices. Devices were wrist-worn and surface-worn sensors that measured accelerometry, heart rate and electrodermal activity parameters.

The meta-analysis of tonic-clonic seizures (TCS) involved thirty-one studies (2,128 patients and 112,542 hours of video-EEG recording), with the mean duration of 53 hours per patient. The overall sensitivity of TCS detection was 89.9% (95% CI: 85.0-93.9%) and the FAR was 1.43 per 24 hours (95% CI: 1.22-1.64). Wrist-worn devices showed slightly higher sensitivity (90.3%) but also higher FAR (1.7/24 h) compared with surface devices (88.1% sensitivity, 0.8/24 h FAR). In the case of focal seizure, nine studies were included, comprising 660 patients and 15,056 hours of observation (average 23 hours in a patient). The pooled sensitivity was 73.5% (95% CI: 57.4-87.0%) and FAR was 2.85/24 h (95% CI: 1.40-5.81). When a study that reported overall sensitivity and non-specific seizure-specific results was eliminated, sensitivity improved to 78.4%.

The findings demonstrate that Wearable devices demonstrate high sensitivity in detecting TCS, with improving false alarm performance compared with earlier evidence. However, focal seizure detection remains more challenging, highlighting the need for improved multimodal sensing, patient-adaptive algorithms, and more rigorous prospective validation studies. This work provides an updated benchmark for wearable seizure detection technologies and identifies key methodological and clinical gaps that must be addressed to improve real-world seizure monitoring.

O24**Neural Systems and Brain Imaging****Friday 4 September 2026** · 15:20-16:20 · Space Four**Chairs:** Dr Wahbi El-Bouri · Professor Liangxiu Han

Synthesis and Magnetic Characterization of Boron-Loaded Nanoparticles for Boron Neutron Capture Therapy in Female-Specific and Brain Cancers

Miss Ece Tezsezen, Dr Jenny Aveyard

Scheduled presenter: Miss Ece Tezsezen · **Organisation:** University of Liverpool · **Programme slot:** 15:20-15:30 · **Order:** 1 · **Paper:** 68

DESCRIPTION OF PROPOSED TALK

Abstract

Introduction

Boron Neutron Capture Therapy (BNCT) is a binary radiotherapy that offers the potential for cellular-level precision. However, a major bottleneck remains: achieving a sufficient concentration of Boron-10 within the tumor while sparing healthy tissue. This study focuses on the synthesis of magnetic nanoparticles as "smart" carriers to improve boron delivery to difficult-to-treat sites, including the breast, cervix, and brain.

Methods

We successfully synthesized a novel boron-containing nanoparticle system with a controlled size of less than 100 nm. Our research focused on characterizing their superparamagnetic properties, which are essential for avoiding particle aggregation in the bloodstream while allowing for "Magnetic Targeting" via external fields. Furthermore, we are currently developing a sugar-based surface coating to facilitate boron loading and improve the particles' biocompatibility and circulation time.

Results

Characterization confirmed that the synthesized particles exhibit strong, stable superparamagnetic behavior at the nanoscale. This size and magnetic profile will be ideal for penetrating biological barriers, such as the Blood-Brain Barrier (BBB) in neuro-oncology or the dense tissue environments of breast and cervical tumors. The results suggest that these particles can be guided by MRI to the tumor site more effectively than traditional small-molecule drugs.

Conclusion

We have successfully established the magnetic and structural foundation for a traceable, high-precision BNCT delivery system. By combining a sub-100 nm superparamagnetic core with a biocompatible coating, this work moves toward a new generation of "theranostic" tools that increase treatment success for aggressive and recurrent cancers.

O24**Neural Systems and Brain Imaging****Friday 4 September 2026** · 15:20-16:20 · Space Four**Chairs:** Dr Wahbi El-Bouri · Professor Liangxiu Han

Fluid-walled microenvironments for optogenetic control and super-resolution imaging of neuronal networks

Mr Alexandros Spyrou, Mr Joseph Morgan, Dr Ricardo Marquez-Gomez, Prof. Richard Wade-Martins, Prof. Edmond Walsh

Scheduled presenter: Mr Alexandros Spyrou · **Organisation:** University of Oxford · **Programme slot:** 15:30-15:40 · **Order:** 2 · **Paper:** 212

DESCRIPTION OF PROPOSED TALK

Microfluidic technologies provide powerful platforms for modelling neuronal systems in vitro; however, conventional PDMS-based devices often limit optical accessibility and experimental interaction with living cells (1). Fluid-walled microfluidics overcomes these limitations by using interfacial tension to create reconfigurable chambers of culture media beneath a bio-inert FC40 oil overlay, enabling unrestricted optical access and direct manipulation throughout experiments (2). Fluid-walled devices have been used in several cell-biology applications, including single-cell cloning (3), bacterial and mammalian cell migration (4) and neuronal culture (5).

Here, we present a fluid-walled microenvironment platform designed for the interrogation of neuronal activity using optogenetics and high-resolution fluorescence imaging. Fluid-walled chambers are generated by jetting FC40 through submerged media, locally displacing liquid to form stable fluid boundaries. These dynamically reconfigurable architectures support long-term culture of human iPSC-derived neurons while maintaining compatibility with advanced optical techniques.

The open geometry and exceptional optical clarity of fluid-walled devices enable integration with optogenetic stimulation approaches for spatially controlled neuronal activation, in co-cultures of different neuron types. In parallel, the absence of solid microchannel ceilings minimises optical aberrations and improves compatibility with super-resolution microscopy, allowing detailed visualisation of neurite morphology, synaptic organisation, and activity-dependent structural changes.

By combining fluid-walled microfluidics with optogenetic interrogation and super-resolution imaging, this platform enables the study of neuronal connectivity and function within precisely defined microenvironments. Furthermore, the ability to reconfigure fluid boundaries during experiments enables localised chemical perturbation, compartmentalisation, and selective neuronal stimulation within the same culture system.

Long-term culture (>50 days) of human iPSC-derived neuronal co-cultures within these fluid-walled microenvironments demonstrates both biocompatibility and structural stability. Fluorescence imaging and immunocytochemistry confirm successful neuronal differentiation and maturation. Together, these results establish fluid-walled microfluidics as a highly accessible and adaptable platform for studying neuronal circuitry and neurodegenerative disease mechanisms with advanced optical interrogation techniques.

O24**Neural Systems and Brain Imaging****Friday 4 September 2026** · 15:20-16:20 · Space Four**Chairs:** Dr Wahbi El-Bouri · Professor Liangxiu Han

Vibration Transmissibility Analysis in a Biofidelic Human Brain Model

Mr Shivam Verma, Dr. Arnab Banerjee, Dr. Arnab Chanda

Scheduled presenter: Mr Shivam Verma · **Organisation:** Indian Institute Of Technology Delhi · **Programme slot:** 15:40-15:50 · **Order:** 3 · **Paper:** 140

DESCRIPTION OF PROPOSED TALK

Vibrations can have detrimental effects on the human brain, potentially leading to neurological injuries, cognitive impairments, and an increased risk of traumatic brain injury (TBI), particularly under low-frequency excitation encountered during blast exposures, contact sports, and accidents. Such vibrations may induce resonance within the brain, resulting in elevated mechanical stress and strain on neural tissues. In this study, the mechanical response of the human cerebrum to vertical vibrations in the frequency range of 1-12 Hz was investigated using both experimental testing and mathematical modeling. A full-scale biofidelic human brain model was developed using a multi-part polymeric material cast into a 3D-printed negative brain mold to closely replicate the mechanical properties of the human cerebrum. The model was subjected to controlled vertical vibrations, and transmissibility across different brain regions was analyzed to identify resonance and anti-resonance frequencies. The results revealed a primary resonance peak of the cerebrum between 4-4.2 Hz, consistent with previous studies, while enhanced transmissibility was observed in the temporal lobe at 8 Hz. Furthermore, the left and right hemispheres exhibited resonance peaks at 2, 9, and 11 Hz, along with a distinct anti-resonance point. Overall, the cerebrum demonstrated higher transmissibility compared to other body parts, indicating greater susceptibility to vibration-induced mechanical stress. These findings provide valuable insights into the segmental vibration transmissibility of the human brain and help identify regions most vulnerable to mechanical loading during low-frequency vibration exposure. The outcomes of this study can support the development of improved protective equipment, reduce dependence on human and animal testing, and contribute to enhanced prevention and rehabilitation strategies for traumatic brain injuries.

O24**Neural Systems and Brain Imaging****Friday 4 September 2026** · 15:20-16:20 · Space Four**Chairs:** Dr Wahbi El-Bouri · Professor Liangxiu Han

Fast micro-field classification of glioblastoma infiltrative-margin patterns in haematoxylin and eosin histology

Mr Feng He, Mr Hok Lam Lee, Mr Jonathan Bartlett, Mr Ziyu Ye, Ms Cheuk Tung Lau, Professor Christos Bergeles, Professor Sebastien Ourselin, Dr Shufan Yang, Professor Keyoumars Ashkan, Dr Wenfeng Xia

Scheduled presenter: Mr Feng He · **Organisation:** King's College London · **Programme slot:** 15:50-16:00 · **Order:** 4 · **Paper:** 124

DESCRIPTION OF PROPOSED TALK

Fast intraoperative feedback is critical in glioblastoma surgery, where surgeons aim to remove as much tumour as safely possible while preserving functional brain. A major difficulty is the infiltrative margin: residual tumour cells near the resection boundary may contribute to local recurrence and influence whether additional tissue should be sampled or removed. The clinical task is therefore not simply to diagnose glioblastoma, but to rapidly interpret small haematoxylin and eosin (H&E) tissue fields as non-tumour brain, leading edge, tumour or necrosis. An automated method that is accurate and computationally fast could support margin-oriented review, targeted pathological assessment and responsive surgical decision-making.

We developed an automated histology pipeline for classifying glioblastoma infiltrative-margin patterns using H&E-stained whole-slide images from the Ivy Glioblastoma Atlas Project, a curated human glioblastoma dataset with expert-defined anatomical tumour-region annotations. Whole-slide images were divided into 256×256 -pixel tissue fields, corresponding to approximately $128 \times 128 \mu\text{m}$ at the native IvyGAP resolution, and aligned with pixel-level annotations. After excluding low-tissue and slide-border regions, each field was labelled according to the dominant annotated tissue type. The original IvyGAP annotations were consolidated into four clinically meaningful categories: non-tumour, leading edge, tumour and necrosis.

The deployment-oriented model used H0-mini, a compact pre-trained histology model, to extract visual features from each tissue field. Instead of re-training the full model, each field was converted into a numerical feature representation and classified using a lightweight downstream classifier. UNI-2, a larger pre-trained histology model, was evaluated as a high-capacity comparator to quantify the additional performance gained at higher computational cost.

Evaluation used whole-slide cross-validation, with complete slides separated between training and testing to avoid overly optimistic results from neighbouring fields. H0-mini classified 83.0% of $128 \times 128 \mu\text{m}$ tissue fields and achieved an area-under-the-curve score of 0.925. It processed 3,512 tissue fields from a representative slide in 8.0 seconds, corresponding to 2.27 ms per field and 440 fields per second. UNI-2 achieved slightly higher accuracy and area under the curve, 83.8% and 0.931 respectively, but required 33.2 seconds for the same slide. Dense inference converted local predictions into spatial tissue maps, achieving 80.2% mean agreement with ground-truth annotations across test slides.

This work demonstrates fast micro-field classification of glioblastoma infiltrative-margin patterns in H&E histology. By combining tissue-field classification, spatial prediction maps and eight-second slide-level inference, this pipeline supports intraoperative workflows requiring rapid, interpretable tumour-margin assessment.

O24**Neural Systems and Brain Imaging****Friday 4 September 2026** · 15:20-16:20 · Space Four**Chairs:** Dr Wahbi El-Bouri · Professor Liangxiu Han

Hierarchical phase-contrast tomography enables microscale investigation of hard and soft tissue anatomy in the intact human spine

Miss Isla Henderson, Aikta Sharma, Alissa L. Parmenter, Joseph Brunet, Christian Liebsch, Jishizhan Chen, Theresa Urban, Joanna Purzycka, Hector Dejea Velardo, Timothy J. P. Bray, Alexandre Bellier, Paul Tafforeau, Peter D. Lee

Scheduled presenter: Miss Isla Henderson · **Organisation:** University College London · **Programme slot:** 16:00-16:10 · **Order:** 5 · **Paper:** 64

DESCRIPTION OF PROPOSED TALK

Introduction

Back pain is the leading cause of years lived with disability, affecting over 600 million people worldwide [1]; it is commonly associated with degenerative spinal conditions including osteoarthritis and intervertebral disc (IVD) degeneration. Despite this clinical burden, the structural mechanisms that underpin the initiation and progression of these conditions remain poorly understood. This is in part due to the low spatial resolution of conventional clinical imaging modalities. To overcome this, we apply Hierarchical Phase-Contrast Tomography (HiP-CT) [2], a synchrotron X-ray imaging technique, to resolve hard and soft tissues of an intact human spine at near-micron scale for the first time.

Methods

An intact human spine (C1-L5) was obtained from a 62-year-old male donor with no known history of spinal pathology and chemically fixed prior to imaging. First, clinical 3 T MRI (T1w-, T2w-, T2*w-, T2w-STIR sequences) was performed, followed by HiP-CT. For HiP-CT, the spine was mounted in formalin-agar solution within a polycarbonate cylinder and imaged on BM18 beamline (16.26 μ m/voxel) at the European Synchrotron Radiation Facility (MD1290/1389), with local zooms conducted at key hard-soft tissue boundaries (2.2 μ m/voxel). IVD degeneration was assessed using the Pfirrmann grading scale [3]. Vasculature and nervous tissue structures were semi-automatically segmented following tomographic reconstruction using a bounded region-growing algorithm in VG Studio Max (v2025.3). Fibres in the IVD were traced using the XFiber module in Avizo 3D.

Results

HiP-CT enabled high-resolution visualisation of the spine's hard and soft tissue anatomy without the use of exogenous contrast agents. Three-dimensional renderings of segmented structures, combined with virtual sectioning, permitted microscale characterisation of the vertebral trabecular and vascular network, IVD fibre architecture, endplate microvasculature and neural elements which could not be resolved by clinical MRI. Furthermore, disruption of collagen fibre architecture within the IVD was identified in HiP-CT datasets and quantified via fibre tracing but these signs of herniation were not detected using MRI-based Pfirrmann grading.

Conclusion

This study shows the utility of HiP-CT for multiscale visualisation of coupled hard-soft tissue architectures in an intact, ex vivo, human spine. By linking MRI-visible features to their microstructural origins, HiP-CT bridges the gap between clinical imaging and pathology and potentially enables the discovery of predictive structural biomarkers of spinal degeneration.

024**Neural Systems and Brain Imaging****Friday 4 September 2026** · 15:20-16:20 · Space Four**Chairs:** Dr Wahbi El-Bouri · Professor Liangxiu Han

Digital twins for dementia: linking vascular and brain health

Miss Amanda Thobega

Scheduled presenter: Miss Amanda Thobega · **Organisation:** University Of Liverpool · **Programme slot:** 16:10-16:20 · **Order:** 6 · **Paper:** 172

DESCRIPTION OF PROPOSED TALK

Introduction

Dementia is a growing global health challenge. Increasing evidence shows a strong relationship between vascular risk factors and cognitive decline[1]. Alongside demographic and clinical data, current prediction models rely on structural neuroimaging features such as white matter hyperintensities and brain atrophy[2]. Dynamic, mechanistic models of vascular physiology, that allow us to simulate changes to cerebral blood flow, are often missing from these prediction models. A key prerequisite for these models is the generation of accurate, fully connected cerebrovascular graphs from medical imaging. Deep learning-based vessel segmentation has shown promising results for cerebrovascular reconstruction[3], but challenges remain in adapting these methods to datasets without manual annotations.

Methods

This work focused on developing a cerebrovascular segmentation pipeline to support future blood flow simulation and digital twin modelling. An nnU-Net model[4] was initially trained and validated using the TopCoW dataset containing labelled Circle of Willis segmentations from TOF-MRA images[5]. Model performance was evaluated on two external datasets. To enable application within a dementia cohort, a semi-supervised domain adaptation strategy was explored using the OASIS-3 dataset, which contains extensive clinical and imaging data but no vessel annotations[6]. Two independently trained segmentation models, nnU-Net and CESAR, were trained on the labelled multi-centre COSTA dataset[7]. These models were used to generate pseudo-labels on OASIS-3 based on inter-model agreement and confidence. These pseudo-labels were then used to fine-tune an OASIS-specific nnU-Net model.

Results

The initial experiment using an nnU-Net model trained on the TopCoW dataset achieved strong segmentation performance on external datasets, with a mean Dice Similarity Coefficient (DSC) of 0.94, Intersection over Union (IoU) of 0.88, and sensitivity of 0.93. Agreement analysis between the COSTA-trained nnU-Net and CESAR models on OASIS-3 showed a mean DSC of 0.90, supporting the use of inter-model agreement as a proxy for pseudo-label reliability. Evaluation on the held-out COSTA test set showed that the COSTA-trained nnU-Net and CESAR models achieved mean DSC scores of 0.950 and 0.965 respectively, while the OASIS fine-tuned nnU-Net model achieved a mean DSC of 0.807. Although performance decreased following transfer to OASIS-3, the approach successfully generated vessel segmentations within a previously unlabelled cohort.

Conclusion

This work demonstrates the feasibility of applying a semi-supervised domain adaptation approach to cerebrovascular segmentation in a dementia dataset lacking manual annotations. Accurate vessel segmentation is an essential first step toward generating fully connected vascular graphs for cerebral blood flow simulation and digital twin modelling.

025**Biomaterials III: smart materials and advanced manufacture****Friday 4 September 2026** · 15:20-16:20 · Space Five**Chairs:** Professor Hazel Screen · Dr Jenny Hanson

Engineering Bioresorbable Bioactive Composites for Musculoskeletal Repair

Dr Sujitha Kunalan, Dr Emiliano Bilotti, Professor Simon C F Rawlinson, Professor Karin A Hing

Scheduled presenter: Dr Sujitha Kunalan · **Organisation:** Queen Mary University of London · **Programme slot:** 15:20-15:30 · **Order:** 1 · **Paper:** 163

DESCRIPTION OF PROPOSED TALK

Introduction

Each year in the UK, complications arising from musculoskeletal repair pose a significant challenge to both patients and the healthcare system. Affecting up to 10% of cases, these complications frequently necessitate additional surgeries, further implantations, and prolonged rehabilitation, resulting in an estimated annual cost of £400 million [1]. To address this issue, there is a need to develop bioactive biomaterials for musculoskeletal repair that actively support or encourage the bone repair process. However, in some cases, such as the treatment of children whose skeletons are actively growing, the presence of an implant permanently at the site of repair can be an issue in the longer term. In these cases, there is an additional need for the biomaterial to be bioresorbable, i.e., to controllably biodegrade over time and be remodelled into native bone tissue. To date, biomaterials have been developed that partially meet these needs; however, issues around the release of particulates or the elevation of the local pH during the bioresorption step can result in complications.

Methods

To address this unmet clinical need, studies have been performed to investigate the potential of a composite system comprising poly-lactic acid, a renewable, plant-based polymer, with silicate-substituted hydroxyapatite, a pro-osteogenic bioceramic with proven clinical performance. A series of compositions was compounded and processed into injection-moulded specimens. Specimens underwent a series of mechanical tests to determine their mechanical behaviour in tensile, flexural, and compressive modes, as well as in vitro degradation (in PBS) and cell testing (with L929 fibroblasts and human mesenchymal stem cells) to investigate pH during degradation, cytotoxicity, and osteoconductivity.

Results and Discussion

A computational Design of Experiments approach enabled the systematic production and testing of composite formulations, demonstrating mechanical tunability through variations in filler characteristics and additions up to 40 wt%. In vitro degradation studies showed that the composites degraded without significantly affecting local pH and retained 42% of their strength for 6 months. Additionally, in vitro cell culture assays confirmed that the composites were non-cytotoxic and promoted a pro-osteogenic response. Correlated ALP and Alizarin Red results indicated that incorporating SiHA substantially enhanced early osteogenic differentiation compared to PLA and PLA-HA composites analysed in the literature [2].

Conclusion

Overall, the development of tuneable, bioresorbable bioactive implants presents a significant opportunity to improve patient quality of life and advance precision medicine strategies for musculoskeletal repair.

025**Biomaterials III: smart materials and advanced manufacture****Friday 4 September 2026** · 15:20-16:20 · Space Five**Chairs:** Professor Hazel Screen · Dr Jenny Hanson

Advanced Manufacturing Strategies for Tissue Engineering and Sensing Devices

Dr David Alexander Gregory

Scheduled presenter: Dr David Alexander Gregory · **Organisation:** University of Sheffield · **Programme slot:** 15:30-15:40 · **Order:** 2 · **Paper:** 170

DESCRIPTION OF PROPOSED TALK

Reactive Inkjet Printing (RIJ) is emerging as a powerful platform for the digital fabrication of functional materials and devices. Unlike conventional inkjet printing, RIJ exploits localised chemical reactions at the point of deposition, enabling the in-situ synthesis and spatial patterning of active materials with high precision. This capability offers unique opportunities for tissue engineering and sensing applications where sensitivity, selectivity, biocompatibility, and miniaturisation are paramount.

Recent advances from the Advanced Manufacturing and Sensing Group demonstrate the versatility of RIJ and related advanced manufacturing approaches for biomedical and sensing applications.

A significant focus of this work involves the processing and application of silk-based biomaterials. Different extraction and processing methodologies for silk fibroin and sericin are investigated, alongside comparisons of molecular weight distributions resulting from degumming and dissolution processes and their differences relative to native silk structures. The ability to tailor molecular weight and structural organisation enables control over mechanical behaviour, degradation, and biological interactions.¹

Circulating tumour cell detection devices based on silk biomaterials have been developed in which RIJ is harnessed to pattern functional interfaces tailored for selective cell capture and analysis. RIJ-printed silk micro-stirrers for contamination detection are also explored, illustrating how printed micro-actuators can be integrated into liquid-phase sensing environments and microfluidic systems.^{2,3}

Advances in the RIJ fabrication of corneal repair scaffolds and modelling of repair patch effects on the eye are presented. In addition, the production of silk microneedles is discussed as a route towards minimally invasive biomaterial-based delivery and sensing systems. Finally, the fabrication of multivariate metal-organic framework (MOF) gradients via RIJ is presented, enabling tuneable analyte interactions and offering new opportunities for responsive sensing platforms.⁴

Together, these studies underline the potential of advanced manufacturing and reactive printing as flexible, low-waste, and scalable approaches for engineering next-generation biomaterials and sensing devices for regenerative medicine, diagnostics, and biomedical analysis.

025**Biomaterials III: smart materials and advanced manufacture****Friday 4 September 2026** · 15:20-16:20 · Space Five**Chairs:** Professor Hazel Screen · Dr Jenny Hanson

Label-free tracking of nanoparticle and microbial dynamics at biological interfaces

Genevieve Schleyer, Eann A. Patterson, Judith M. Curran

Scheduled presenter: Miss Genevieve Schleyer · **Organisation:** University of Liverpool · **Programme slot:** 15:40-15:50 · **Order:** 3 · **Paper:** 32

DESCRIPTION OF PROPOSED TALK

Advancing antimicrobial technologies requires tools that can capture how nanoscale materials and microorganisms behave in complex biological environments prior to interaction. These early-stage interactions critically influence infection progression and treatment, yet they remain poorly understood due to reliance on fluorescent labelling, end point measurements or sophisticated equipment needs. There is a need for accessible, label-free approaches that can quantify particle and microorganism dynamics directly within biologically representative systems. Such approaches are key to informing the rational design and development of antimicrobial interventions. In this study, nanoparticles are employed as well-defined proxies for bacteria to establish the sensitivity limits of the technique and to model microbial-scale transport phenomena in controlled conditions.

A real-time optical platform based on caustic phenomena is presented that transforms a standard inverted microscope into a sensitive nanoparticle tracking system [1]. By generating optical signatures orders of magnitude larger than the tracked object, this approach enables label-free detection and tracking of nanoscale entities. The protocol was first validated using charged gold nanoparticles and functionalised PEG nanoparticles (100 nm), serving as bacterial proxies to characterise the lower detection limits and baseline diffusion behaviours in the extracellular microenvironment up to 100µm above human keratinocyte (HaCaT) and mesenchymal stem cell monolayers. Diffusion metrics were obtained from trajectory analysis including diffusion coefficients, convex hull areas and anomalous diffusion exponents. To demonstrate antimicrobial relevance, the system was extended to biological agents; *Porphyromonas gingivalis* was tracked above inflamed and healthy gingival fibroblast layers, modelling infection-relevant conditions.

Distinct diffusion behaviours were observed near biological interfaces, with significant variations in nanoparticle mobility linked to cellular phenotype, particle properties, and environmental conditions. These findings reflect the influence of differences in extracellular matrix and protein dynamics in the extracellular microenvironment. The results show the interplay of physicochemical and environmental factors influencing nanoparticle motion near a cell monolayer. The method's adaptability allows for substitution of different cell layers and pathological conditions, enabling wide-ranging investigations of biological interactions at nano- and micro-scales.

The caustics-based tracking approach provides a powerful, label-free method for resolving pre-interaction dynamics of nanoparticles and microorganisms in complex biological systems. By capturing time dependent changes in diffusion and the impact of protein-rich environments, it enables deeper insight into the factors that could potentially govern cellular interactions. This platform offers a valuable route toward tailoring therapeutic strategies and supporting the development of more effective and predictable biomedical technologies.

025**Biomaterials III: smart materials and advanced manufacture****Friday 4 September 2026** · 15:20-16:20 · Space Five**Chairs:** Professor Hazel Screen · Dr Jenny Hanson

Understanding interface interactions between microorganisms and Layered Double Hydroxides substrates

Mr Federico Delle Fave

Scheduled presenter: Mr Federico Delle Fave · **Organisation:** University of Rome Tor Vergata · **Programme slot:** 15:50-16:00
· **Order:** 4 · **Paper:** 30

DESCRIPTION OF PROPOSED TALK

Understanding and controlling cell-material and bacteria-material interactions remains a central challenge in both biomedical research and the development of next-generation biomaterials. In particular, the ability to simultaneously limit bacterial colonisation while promoting mammalian cell function is critical not only for implantable devices, but also for in vitro platforms used to study infection, regeneration, and cell behaviour. In this study, we investigate engineered layered double hydroxide (LDH) nanostructures as multifunctional substrates capable of modulating these interactions. Tailored LDH formulations (ZnAl-LDH and MgAl-LDH) were synthesised and integrated into both two-dimensional coatings and three-dimensional scaffold matrices, enabling the exploration of their behaviour across simplified and more physiologically relevant environments, as well as their scalability for real-world applications.

Our results demonstrate that LDH-functionalised substrates reduce biofilm formation in *E. Coli* and *S. Aureus*, suggesting an intrinsic resistance to bacterial colonisation. At the same time, these materials exhibit high biocompatibility, supporting human mesenchymal stem cell (hMSC) adhesion and proliferation. Moreover, preliminary observations indicate that LDH-based substrates may also promote osteogenic differentiation while reducing the dependence on exogenous growth factors.

Beyond their direct application in implantable systems, these findings position LDH nanostructures as promising platforms for studying the interplay between microbial colonisation and tissue regeneration in controlled in vitro settings. This dual functionality opens new opportunities for the design of bioactive materials that bridge fundamental research and clinical translation in tissue engineering and infection control.

025**Biomaterials III: smart materials and advanced manufacture****Friday 4 September 2026** · 15:20-16:20 · Space Five**Chairs:** Professor Hazel Screen · Dr Jenny Hanson

Biaxial Mechanical Characterisation of Biodegradable Polymeric Films under Hydrolytic Degradation

Dr Huidong Wei, Amul Raj.

Scheduled presenter: Dr Huidong Wei · **Organisation:** University of Huddersfield · **Programme slot:** 16:00-16:10 · **Order:** 5 · **Paper:** LB07

DESCRIPTION OF PROPOSED TALK

Synthetic polymeric films and membranes are widely used in medical devices for abdominal wall hernia repair and guided bone reconstruction. Biodegradable polymers emerge as a new alternative to traditional materials by progressive degradation during their service lifespan inside the human body. One degradation factor is the breakdown of chemical bonds of molecules due to hydrolysis, leading to the loss of structural integrity that need to be addressed during the tissue curing process. To characterise the mechanical behaviour of material under degradation, most research relies on uniaxial test whilst the material is subject to complex biaxial loading conditions at real operations. Some literatures introduced biaxial testing of films but rarely considering the influence of degradation.

This study investigates the biaxial mechanical behaviour of biodegradable films from polylactic acid (PLA) under controlled hydrolytic degradation. Extruded specimens are prepared and immersed in water bath at physiological temperature and above. Samples are retrieved at pre-determined intervals over a two-week period. A custom-built bulge testing rig is developed to test the biaxial loading behaviour of degraded materials. Quantitative The stress-strain relationship of materials is acquired by capturing the deflection of films during bulging process by image tracking method. Thermal analysis and mass spectrometry method is used to study the change of microstructures of materials before and after degradation and build the relevance to the macroscopic mechanical performance.

A slow degradation under physiological conditions is observed by negligible mass change within two weeks but more evident mass growth (3 to 5 percent) by increasing operation temperature. The deflection curve of degraded PLA films shows minor difference at low pressure but high deviations above 1.2 bar. The 1 and 14-day pressure-deflection curve shows a lower ultimate elongation, but higher stiffness compared to raw materials. A special performance at 7-day degradation is observed at transition position. The stress-strain relationship demonstrates that 7-day degradation has similar stress response to the raw material at low strain level of less than 0.15%, but stronger strain-hardening behaviour beyond. The 1 and 14-day degradation introduces higher yield stress and elevated strain hardening compared to raw materials and 7-day degradation.

Compared to 3D printed PLA, the extruded polymer films showed a higher resistance to the hydrolysis at body temperature. It highlighted weakened ductility of PLA under accelerated degradation due to the breakdown of molecular bonds under hydrolysis but enhanced strain-hardening behaviour by restricted segmental mobility and a transition period (7 days) for molecular reorganisation.

O26**Craniofacial, Soft-Tissue and Sports Biomechanics****Friday 4 September 2026** · 15:20-16:20 · Space Six**Chairs:** Dr Tom Allen · Professor Michael Crichton

Wearable sleep posture classification using one-shot learning of biomechanical signatures

Dr Omar Elnaggar, Dr Roselina Arelhi, Professor Frans Coenen, Dr Andrew Hopkinson, Dr Paolo Paoletti

Scheduled presenter: Dr Omar Elnaggar · **Organisation:** Queen Mary University of London · **Programme slot:** 15:20-15:30 · **Order:** 1 · **Paper:** 210

DESCRIPTION OF PROPOSED TALK

Prolonged sleep in provocative postures has been associated with musculoskeletal symptoms [1], yet current sleep posture monitoring approaches typically recognise only a small set of standard positions and often require large annotated datasets that are difficult to obtain during natural sleep [2-4]. This work evaluates wearable-derived joint kinematics as clinically meaningful biomechanical markers for recognising complex, non-standard sleep postures that may be more relevant to musculoskeletal assessment than conventional supine, prone, or lateral labels [2,5].

A body sensor network comprising eight magneto-inertial measurement units was used to estimate posture-related kinematic signatures [2]. Sensor fusion was applied to derive four extremity joint orientations, corresponding to the wrists and ankles, which capture clinically interpretable limb configurations while reducing reliance on high-dimensional raw sensor data [2]. To address the scarcity of labelled sleep data, a one-shot learning scheme generated synthetic training samples from a single measured example of each posture [2]. The framework was assessed across three feasibility phases: an in-silico study using a computer-graphics character model, a controlled in-vivo study conducted in conditions selected to minimise orientation drift, and a more realistic indoor in-vivo study using commercial inertial sensors with proprietary drift compensation [2,5].

The in-silico study achieved 100% classification accuracy across twelve complex sleep postures [2]. In the controlled in-vivo study, an average of eleven postures could be reliably classified, with approximately 90% accuracy, indicating that one-shot augmentation can accommodate mild-to-moderate variability in posture replication [2]. Further analysis showed that inter-posture similarity is an inherent challenge when distinguishing complex sleep configurations, particularly where visually similar poses differ only in extremity orientation [2]. The realistic indoor study presented a harder classification problem because of substantial orientation drift, despite the use of drift-compensated commercial sensors. Nevertheless, the proposed one-shot approach classified seven non-standard postures, compared with five when no synthetic augmentation was used [2].

These findings support wearable-derived extremity kinematics as interpretable markers for complex sleep posture analysis [2,5]. The results suggest that clinically informed posture signatures, combined with limited-data learning, can extend wearable sleep monitoring beyond coarse standard posture categories [2-4]. The work also highlights important translational challenges, especially sensor orientation drift and similarity between postures, that must be addressed before robust long-term deployment in home or clinical environments [2,5].

026**Craniofacial, Soft-Tissue and Sports Biomechanics****Friday 4 September 2026** · 15:20-16:20 · Space Six**Chairs:** Dr Tom Allen · Professor Michael Crichton

Do Locking Plates Offer any Biomechanical Advantage in Good Quality bone

Mr Piyush Upadhyay, Dr Mili Jayadeep, Mr Gurbinder Nandhara, Mr Ayaz Lakdawala, Mr Vineet Trivedi, Prof Michael Chappell

Scheduled presenter: Mr Piyush Upadhyay · **Organisation:** Warwick University/ George Eliot Hospital · **Programme slot:** 15:30-15:40 · **Order:** 2 · **Paper:** 195

DESCRIPTION OF PROPOSED TALK

Background

Fractures of the bone can be stabilised with plates. Locking compression plates (LCP) demonstrate established advantages in osteoporotic fractures¹, comparative biomechanical data in good quality bone remains limited. This study evaluated the static and fatigue performance of 3.5mm Medial Distal Tibia LCP applied in three configurations: bicortical locking, unicortical locking, and conventional non-locked compression plating.

Methods

An oblique metaphyseal fracture (AO 43-A2.3) with 10mm gap was created in third-generation composite tibiae² to simulate, load-bearing conditions for the applied plate. Third generation composite tibiae have mechanical properties similar to healthy bone.

Static testing assessed axial failure load, axial stiffness, displacement at failure, torsional torque at 5°, 10°, 15°, and 20°, and torsional stiffness. Axial and angular actuators were set to 1 mm/min and 1°/min.

Fatigue testing simulated a six-week graded weight-bearing protocol (250,000 cycles at 3Hz), increasing load by 400N biweekly³. Statistical analysis employed ANOVA with $p < 0.05$ significance.

Five specimens were tested per construct.

Results

Static axial testing revealed non-locked compression plates demonstrated superior performance with highest failure loads (683N versus 575N bicortical versus 483N unicortical) and axial stiffness (633 N/mm versus 337 N/mm versus 266 N/mm respectively; $p < 0.01$).

Torsionally, compression plating exhibited superior resistance across all angular displacements, with stiffness ranked: compression (1.16 Nmm) > bicortical locking (0.79 Nmm) > unicortical locking (0.40 Nmm).

Fatigue testing showed non-locked plates demonstrated least residual deformation at loads exceeding 400N ($p < 0.05$).

Clinical Implications

Contrary to contemporary surgical preferences, locking plates provided no biomechanical advantage over conventional compression plating in non-osteoporotic bone⁴. The superior performance of compression plates derives from bone-plate interface friction⁵, which proves highly effective when bone quality permits adequate torque application. These findings align with literature demonstrating locking plates primarily benefit osteoporotic scenarios where conventional fixation cannot generate sufficient friction forces⁶.

Conclusion

For distal tibial fractures in patients with good bone quality, conventional compression plating offers superior biomechanical performance compared to locking constructs in both static and fatigue conditions⁷. This challenges the default application of locking technology and emphasizes that plate selection should be bone quality-dependent rather than technology-driven⁸. The study provides evidence-based guidance for optimising fracture fixation strategies, suggesting that in non-osteoporotic bone, traditional principles of compression plating remain biomechanically superior. These findings have important implications for surgical decision-making and cost-effectiveness in fracture management.

026**Craniofacial, Soft-Tissue and Sports Biomechanics****Friday 4 September 2026** · 15:20-16:20 · Space Six**Chairs:** Dr Tom Allen · Professor Michael Crichton

Kinematic comparison of smart leggings and optical motion capture in elite female football players

Ms Lucinda Abell Black, Dr Thomas Balshaw, Dr Stuart McErlain-Naylor

Scheduled presenter: Ms Lucinda Abell Black · **Organisation:** Loughborough University & Independent Smart Garment Specialist · **Programme slot:** 15:40-15:50 · **Order:** 3 · **Paper:** 108

DESCRIPTION OF PROPOSED TALK

Anterior cruciate ligament (ACL) and hamstring injuries represent a major concern in women's sport, including football [1], with women approximately two to five times more likely than men to sustain non-contact ACL injuries [2, 3]. Despite this risk, the underlying biomechanical mechanisms remain poorly understood, partly due to limitations in measuring movement in naturalistic settings. Laboratory-based optical motion capture is precise but time-consuming and removes athletes from real-world sporting environments.

Advances in wearable technology, including smart garments with inertial measurement units (IMUs), offer a practical alternative, provided their measurement properties are established. These systems may support large-scale injury risk screening and longitudinal monitoring.

Therefore, this study aims to evaluate the agreement and reliability of lower limb kinematics from female-specific smart leggings, incorporating seven miniaturised IMUs (50 Hz), against a marker-based Vicon motion capture system (200 Hz). The inclusive smart garment design was informed by iterative user-centred development with female athletes, including refinement of sensor placement and garment sizing to support consistent sensor alignment during dynamic movement.

With institutional ethical approval and informed consent, 16 tier-three female football players (mean $\pm$ SD age: 20.3 $\pm$ 2.9 years; body mass: 63.9 $\pm$ 5.9 kg; stature: 167.5 $\pm$ 6.0 cm) participated in a laboratory validation battery, including controlled bilateral and unilateral movements, linear sprinting, and high-speed change-of-direction tasks. Hip, knee, and ankle joint kinematics were recorded across sagittal, frontal, and transverse planes. Data synchronisation used pre-trial static standing and threshold-based movement-onset detection in both systems, with dynamic tasks verified using initial-contact events identified from foot-mounted IMU signals and corresponding Vicon criteria.

To address sampling differences, Vicon kinematics were low-pass filtered and resampled to 50 Hz for agreement analysis. Sampling-frequency effects will be examined by comparing Vicon 200 Hz and resampled 50 Hz outputs. Outcome variables include peak and event-specific joint angles across planes (e.g., flexion at initial contact and toe-off), temporal measures, and continuous waveforms. Results will be quantified using root mean square error, intraclass correlation coefficients, and Bland-Altman limits of agreement. Data analysis is ongoing, and validation outcomes will be presented in an updated abstract prior to the conference.

Findings

will inform the deployment of embedded IMU garments for applied movement monitoring in women's football, and similar multidirectional sports, defining the capabilities and limitations of 50 Hz wearable systems relative to laboratory motion capture.

026**Craniofacial, Soft-Tissue and Sports Biomechanics****Friday 4 September 2026** · 15:20-16:20 · Space Six**Chairs:** Dr Tom Allen · Professor Michael Crichton

Reassessing the functional significance of the temporal fascia in cranial biomechanics

Dr Andrew Cuff, Dr Laura Fitton, Dr Alana Sharp

Scheduled presenter: Dr Alana Sharp · **Organisation:** University of Liverpool · **Programme slot:** 15:50-16:00 · **Order:** 4 · **Paper:** 4

DESCRIPTION OF PROPOSED TALK

As one of the major masticatory muscles, the temporalis produces a large amount of force and plays a vital role in controlling jaw movement, particularly jaw closing. Previous studies of humans and primates have suggested that the temporal fascia that cover the muscle plays an important, but understudied role, in modulating zygoma strain during feeding. This fascia originates from the skull along the superior temporal line and inserts along the zygomatic arch, thereby counteracting the masseteric forces. Using a combination of experimental work and digital modelling we attempt to test this hypothesis for adult male and female humans. Ultrasound scans were taken at a series of locations across the temporalis during maximal voluntary biting to measure temporalis muscle bulging. MRI scans were used to create a finite element (FE) model of the temporal fossa region, including the temporalis and overlying temporal fascia. The temporalis muscle was expanded in a pattern that replicated the ultrasound measurements and the forces on the zygoma were extracted. Full FE models of the crania were then created of various biting conditions with and without the temporal fascia forces added. The temporal fascia for both male and females produces very small (<5 N) forces on the zygoma. Both FE models of incisor bites show negligible difference in strain magnitudes and patterns between the different fascia loading conditions, including applying 10 times the predicted forces. In addition, the models show that removing the temporal fascia has negligible effect on strains, either locally at the zygoma or across the cranium as a whole. Whilst soft tissues do play an important role in cranial function, such as cranial sutures, the temporal fascia does not appear to be one of them, at least in humans. However, modern humans have a comparatively reduced masticatory apparatus; therefore, in other species, the fascia may have a larger role associated with relative force contribution of the temporalis and masseter muscles relating to dietary specialisations.

O26**Craniofacial, Soft-Tissue and Sports Biomechanics****Friday 4 September 2026** · 15:20-16:20 · Space Six**Chairs:** Dr Tom Allen · Professor Michael Crichton

Holding the Head Steady: Neck Strength in Mitigating Brain Injury Risk in Sport

Dr Elisabeth Williams

Scheduled presenter: Dr Elisabeth Williams · **Organisation:** Swansea University · **Programme slot:** 16:00-16:10 · **Order:** 5 · **Paper:** 182

DESCRIPTION OF PROPOSED TALK

Neck strength and the rate of force development (RFD) of the cervical musculature are increasingly recognised as important factors in mitigating sport-related concussion risk. However, these remain underexplored, with no current gold standard method for assessing neck function that allows meaningful comparison[1]. Existing protocols vary considerably in testing position and measurement approach, including fixed-frame dynamometry, hand-held devices, and clinician- or athlete-applied loading methods, limiting comparability[1].

Given the role of the neck in stabilising the head during high-velocity impacts, both maximal strength and rapid force generation are likely critical in mitigating injurious head accelerations. Effective stabilisation requires the ability to generate force within very short time frames; however, most studies focus solely on maximal isometric strength and not RFD. Peak force alone may be insufficient, as athletes may not reach maximal contraction before impact, highlighting the importance of early-phase force production[2]. Emerging evidence also suggests that cervical strength characteristics, including RFD and neuromuscular control, may contribute to reducing head acceleration events, although findings remain inconsistent due to methodological heterogeneity[3].

This study utilised a novel isometric neck strength testing apparatus (INSTA), designed to improve repeatability through a supported, restrained prone position that limits accessory muscle contribution. Neck strength was assessed in rugby union players across seven teams. Maximal isometric strength was measured in four directions: flexion, extension, and left and right lateral flexion. For two teams, RFD was introduced as an additional measure, given its relevance to rapid force generation during impact and potential role in attenuating head acceleration[4].

We will present findings of substantial sex- and level-based differences in neck strength. Previous work has demonstrated markedly lower neck strength in female rugby players compared to males, alongside differences in head impact mechanics, emphasising the need for sex-specific investigation[5]. In professional male players, forwards exhibited significant reductions in neck strength across a playing season, whereas backs maintained or increased strength. This is discussed in the context of longitudinal adaptations and the role of targeted strengthening interventions, shown to increase isometric cervical strength in rugby populations[6].

Collectively, these data highlight the importance of cervical strength characteristics and the ongoing lack of methodological consensus. It is proposed that seated approaches may be complemented by more constrained, sport-specific methods such as the INSTA to develop a more standardised framework. Further research should integrate strength, RFD, and neuromuscular control to better understand the role of the cervical system in mitigating head impact kinematics in sport.

026**Craniofacial, Soft-Tissue and Sports Biomechanics****Friday 4 September 2026** · 15:20-16:20 · Space Six**Chairs:** Dr Tom Allen · Professor Michael Crichton

Design of a prototype shared-control platform to explore multi-modal access of Early-Years Powered Mobility

Dr Lucas Fonseca, MSc Subhaan Ahmed, Dr. Sendy Phang, Dr Tim Adlam, Professor Praminda Caleb-Solly

Scheduled presenter: Dr Lucas Fonseca · **Organisation:** University of Nottingham · **Programme slot:** 16:10-16:20 · **Order:** 6 · **Paper:** LB02

DESCRIPTION OF PROPOSED TALK

In 2023/24, around 12% of children in the UK were disabled, many with mobility-related limitations restricting exploration and participation (House of Commons Library, 2025). Access to Early Years Powered Mobility (EYPM) enables independent movement which can have development benefits (Bray J et al., 2020), but NHS wheelchair services typically assess children for powered chairs from 3 years (BLWS, 2020). In contrast, EYPM devices such as the Designability's Wizzybug offer independent mobility to disabled children aged from 14 months to 5 years (Designability, 2026). However standard joystick-based controls may not be suitable for children with complex motor, sensory or cognitive needs.

We present a prototype platform which can be retrofitted to the chassis of EYPM devices for exploration of personalised alternative control modalities and shared-control approaches. It allows the integration of multiple input modalities, such as carer-operated remote control, camera-based head tracking and wearable IMU-based gesture/pose control which can be mapped to low-bandwidth commands for driving and assisted navigation. An Nvidia Jetson Nano provides edge compute for visual models, safety state machines and intent inference. A Robotics Operating System (ROS2)-based architecture integrates 2D LiDAR for mapping and odometry with depth camera for navigation.

Our modular system architecture enables safety to be enforced through hardware and software, e.g. speed limits, battery power isolation, and situation-aware state machines to warn of and halt motion in unsafe conditions (such as when face cannot be tracked or out of frame). Our design philosophy is to ensure that the child has agency and independence, key for neuro-motor and social skill development. When using the EYPM for play, multi-modal feedback can aid learning and decision-making. Our platform is designed to leverage context-aware layered shared-control models (Casado, 2025) to ensure safety. Here, information such as user presence, nearby objects and speed provides the context for adapting the level of assistance, while the layered architecture distributes control across the user, the autonomous system, and the carer. This can allow for intelligent and adaptable obstacle-avoidance that does not overly constrain play, but also automatically detects and avoids hazards such as stairs.

We report the current technical status of the prototype, including head-control and mapping capabilities, and outline the planned PPIE co-design workshops with children, families and clinicians as part of the next prototyping stage. This work aligns with themes of AI in Bioengineering and Bioengineering Education, and aims to contribute an accessible, low-cost, shared-control framework for early-years powered mobility.

027**Bioengineering Education****Friday 4 September 2026** · 15:20-16:20 · Space Seven**Chairs:** Dr Alison Harvey · Dr Anita Ghag

The Paper That Never Happened: Narrating the Structural Barriers to Producing Equality, Diversity and Inclusion Scholarship in a STEM Research Centre for Doctoral Training (CDT)

Dr Chrissi McCarthy, Dr Alison Harvey, Professor Gwendolen Reilly, Ms Maria McGloin

Scheduled presenter: Dr Chrissi McCarthy · **Organisation:** Centre Of Behavioural Equality · **Programme slot:** 15:20-15:30 · **Order:** 1 · **Paper:** 28

DESCRIPTION OF PROPOSED TALK

Critical evaluation of equality, diversity, and inclusion (EDI) practice remains underdeveloped within biomedical engineering doctoral training environments, despite increasing expectations that funded programmes foster inclusive research cultures and broaden participation. Although EDI activity is frequently promoted within Centres for Doctoral Training, the structural conditions necessary to assess its effectiveness are insufficiently supported. This results in a persistent gap between EDI aspirations, institutional practices, and evidence-informed improvement.

This paper investigates why a planned evaluation of EDI activity within a biomedical engineering Centre for Doctoral Training did not progress beyond ethics approval. Employing narrative inquiry and thematic analysis, the study examines the perspectives of four key stakeholders: two academic CDT leads, a professional services lead, and an external EDI specialist collaborating with the CDT. This approach facilitates comparison across roles, timeframes, and perspectives, offering a comprehensive account of how barriers to critical EDI evaluation emerged in practice. Rather than attributing the disrupted project to individual commitment or research design, the paper uses it as evidence to examine the broader conditions that determine whether EDI evaluation can be meaningfully conducted.

The analysis identifies four interrelated barriers. First, EDI evaluation was deprioritised due to competing organisational demands. Second, evaluation efforts were not safeguarded within workload models. Third, funder structures incentivised EDI activity but did not support sustained evaluation. Fourth, local EDI initiatives were influenced by external pressures beyond the CDT. Collectively, these findings demonstrate that critical EDI evaluation relies not only on methodological rigour and local commitment, but also on supportive organisational and funding conditions.

This paper contributes to scientific knowledge by clarifying the conditions that enable environments in which researchers can thrive. Understanding the factors that support critical EDI evaluation allows institutions to identify which forms of EDI work genuinely strengthen research culture, rather than relying on short-term, activity-based projects. In the context of biomedical engineering doctoral training, these insights have implications for research culture, doctoral training quality, responsible funding practices, and the retention of diverse talent. It is recommended that funders allocate dedicated resources for EDI evaluation, incorporate evaluative planning into funding review processes, and support iterative models in which EDI activity is routinely reviewed, adapted, and improved.

027**Bioengineering Education****Friday 4 September 2026** · 15:20-16:20 · Space Seven**Chairs:** Dr Alison Harvey · Dr Anita Ghag

Short-Form Topic-Focused Recaps in Engineering Education

Dr Abby Blackman

Scheduled presenter: Dr Abby Blackman · **Organisation:** University of Liverpool · **Programme slot:** 15:30-15:40 · **Order:** 2 · **Paper:** 111

DESCRIPTION OF PROPOSED TALK

Students are provided with a wealth of learning resources during their studies. This commonly includes recording of lectures and copies of lecture slides/notes, which are made available for students via a virtual learning environment (VLE). These resources are essential to students who rewatch and review the content whilst studying/revising. This can also be invaluable to students who were unable to make the lecture in person and need to catch up.

The ability for students to maintain attention and meaningfully engage during a lecture is a widely discussed topic. Whilst the reported length of the student attention span varies, [1] it is well established that incorporating active learning into lectures can help improve student engagement, attendance, and performance. [2,3] One such technique is the use of in-lecture quizzes. [4] However, whilst these techniques can improve engagement and motivation during lecture, the interaction can be less meaningful when rewatched online.

Breaking lessons and lectures into smaller and more manageable chunks has been studied in a variety of contexts and subject areas. Whilst this has also been utilised in person, e.g., structured breaks in lectures, [5] 'chunking' online or asynchronous teaching into smaller individual videos has been found to be beneficial for student engagement, attention, and cognitive load. [6]

To further investigate the impact 'chunking' can have for students accessing revision materials, I have applied these concepts to an experimental methods module taken by engineering students which covers topics from data analysis & statistics to instrumentation. By creating short-form topic-focused recaps, I aim to provide students with revision content that is more manageable, aids concentration, and is easy to navigate. To achieve this, for each lecture I broke the lecture recording and accompanying notes into short topic-focused recaps and made them available to students via the VLE.

This is an ongoing educational research project with two main goals: (1) to better understand student perspectives and preferences towards short-form topic-focused recaps and (2) to evaluate whether short-form, topic-focused video recaps are a useful resource for engineering students. Here, I will present my perspective on the success of implementing this, how I adapted my teaching style to support breaking the content into topic-focused recaps, as well as some results from an initial student survey.

027**Bioengineering Education****Friday 4 September 2026** · 15:20-16:20 · Space Seven**Chairs:** Dr Alison Harvey · Dr Anita Ghag

The Educational Digital Twin: A Scalable Framework for Pre-empting Systemic Risks in the Student Journey

Dr Waleed Al-Nuaimy, Dr Harm van Zalinge

Scheduled presenter: Dr Waleed Al-Nuaimy · **Organisation:** University of Liverpool · **Programme slot:** 15:40-15:50 · **Order:** 3 · **Paper:** 138

DESCRIPTION OF PROPOSED TALK

(Secondary theme: Digital Twins)

Academic quality assurance typically relies on lagging indicators like year-end progression statistics. These tell us who fell through the cracks, but only after they have already gone. This research shifts the focus toward a Digital Twin of the student journey. By treating the undergraduate lifecycle as a complex human in the loop system, we apply reliability engineering principles to simulate the experience from recruitment to graduation. This identifies systemic risks before they manifest as student failure or withdrawal.

We use stochastic agent-based modelling to create a high-fidelity emulation of the academic ecosystem. The framework is software-agnostic and designed to scale across different disciplines and contexts. We treat the journey as a series of safety envelopes, applying the Swiss Cheese Model to track how latent procedural gaps align. Student agents carry dynamic variables such as Academic Capital and Emotional Reserve. By simulating how clusters of assessments or administrative delays overlap, we can pinpoint the holes in our support layers in silico.

This moves pedagogy from retrospective observation to predictive simulation. It provides a sandbox to test policy changes in a virtual environment before they impact real lives. The goal is a resilient educational infrastructure that anticipates risks to student success and wellbeing.

027**Bioengineering Education****Friday 4 September 2026** · 15:20-16:20 · Space Seven**Chairs:** Dr Alison Harvey · Dr Anita Ghag

Insights into human-computer interaction based on a user-centred study with people with Learning Disability and Autistic People

Mr Sai Kumar Mattireddy, Dr Zoe Morgan, Dr Jennifer Creese, Dr Traolach Brugha, Dr Samuel Tromans, Dr Himanshu Kaul

Scheduled presenter: Mr Sai Kumar Mattireddy · **Organisation:** University of Leicester · **Programme slot:** 15:50-16:00 · **Order:** 4 · **Paper:** 168

DESCRIPTION OF PROPOSED TALK

Currently, survey design, particularly the user interface, does not consider neurodivergence. Consequently, surveys fail to accommodate people with intellectual disability and autistic people [1]. A study comparing 114 young people with intellectual disabilities against 1,161 peers without disabilities (aged 13-20) found a striking digital divide: only 20% of those with intellectual disability used the internet to search for information, compared to 86% of the general population group [2]. This digital dimension limit accessibility and participation. A critical barrier is that existing guidelines on survey accessibility for people with intellectual disability and autistic people is superficial: e.g. advocating simplifying sentence structures, using graphics alongside options and design survey questions [3], etc. These recommendations do not fully reflect the needs of people with intellectual disability and autistic people, which excludes participation.

To address this challenge, we conducted a study including digital data gathering coupled with online focus groups with people with intellectual disability, autistic people, and carers of people belonging to these groups. The study was approved by the University of Leicester Ethics Committee. We used the LeicSurvey® (Leicester, UK) platform to create a questionnaire in three formats: Easy Read, gamified, and matrix. Recruited participants answered the questionnaire in all three formats. The format order was randomly assigned. At the end, respondents rated the three interfaces on inclusivity, accessibility, and ease of navigation. This was followed by two focus groups, and participant feedback was used to create design guidelines to shape the user interface for people with intellectual disability and autistic people.

The Easy Read version was rated as the most inclusive format: with a weighted average of 2.64/3 (>2x the other options) and ~75% respondents selecting it as their top preferred format, describing it as clear and comfortable. The use of simple language, short questions, supportive visuals, and minimal clicks were highlighted as an asset. The Matrix format was the least preferred (only 1 person rated it as the best), mainly due to cognitive load and dense layout. Additionally, respondents identified the following challenges with responding to questionnaires online: time constraints, survey fatigue, poor survey design.

Our findings suggest that an Easy Read format will elicit higher engagement, richer data, and a highly intuitive user experience for people with intellectual disability and autistic people. They also show that offering multiple formats or control over the user interface is not just a matter of inclusivity but will foster richer, high-quality information exchange.

027**Bioengineering Education****Friday 4 September 2026** · 15:20-16:20 · Space Seven**Chairs:** Dr Alison Harvey · Dr Anita Ghag

Bridging Open and Minimally Invasive Surgery: A Reusable, Reconfigurable Multi-Layered Simulator for Affordable Undergraduate Skills Training

Mr Yuvraj Juttla, Mr Laith Ali, Mr Matthew Boucher

Scheduled presenter: Mr Laith Ali · **Organisation:** University College London · **Programme slot:** 16:00-16:10 · **Order:** 5 · **Paper:** 238

DESCRIPTION OF PROPOSED TALK

Newly qualified doctors are expected to be competent in basic surgical skills, yet medical students have limited exposure to and confidence in procedures, and formal procedural training in undergraduate education has measurably declined [1]. Although the GMC requires competence in basic skills such as wound closure, there is a profound lack of undergraduate exposure to and competence in them [2]. Minimally invasive surgery now dominates many specialities, but student exposure to laparoscopy is largely limited to observation, and the high cost of simulation equipment restricts hands-on training [3]. Cost is perhaps the single biggest obstacle to providing students with laparoscopic practice, and existing low-cost trainers usually address a single task or modality, keeping open and laparoscopic skills separate.

We developed a multi-layered, modular simulator that teaches open and laparoscopic skills within a desktop environment. Synthetic vessels are suspended in the simulator using magnetic clips, allowing reconfiguration of the operative field in seconds - between tasks such as suturing, knot-tying, anastomosis and patch repair. The pedagogical design centres on incremental development; stacked layers allow students and trainees to progress from superficial wound closure to operating at depth, later progressing to indirect visualisation using laparoscopic tools. This allows for training of the visual-spatial and psychomotor skills that learners find difficult, establishing increased confidence prior to theatre exposure. Unlike improvised cardboard trainers, the box has a durable steel construction, with a perforated base that allows wet-lab use and rapid cleaning; it is reusable rather than disposable.

This addresses clear gaps in current provision. Commercial simulators are modality-locked and costly: laparoscopic systems such as eoSim and the FLS box teach minimally invasive skills only. The eoSim range runs roughly £1,500 to £2,800 [4], and the FLS trainer needs a separate monitor and over 100 recurring consumable items [5]. Furthermore, open-bench trainers cannot replicate laparoscopic constraints, forcing institutions to purchase and store two systems. By combining both modalities in one, take-home, reconfigurable unit, our platform reduces the cost, duplication and consumable burden that puts repeated self-directed practice beyond individual students [6,7]. No outcome data exist yet; a planned controlled study would benchmark student confidence, usability and OSATS-style task metrics against a conventional single-task trainer. If validated, the platform offers a scalable, affordable route to widen surgical skills exposure across the undergraduate curriculum and international trainees.

027**Bioengineering Education****Friday 4 September 2026** · 15:20-16:20 · Space Seven**Chairs:** Dr Alison Harvey · Dr Anita Ghag

Delivering the UK's first module in “Women's Health in Biomedical Engineering”: educator and student perspectives

Dr Vanessa Hearnden, Miss Rachel Kovacs

Scheduled presenter: Miss Rachel Kovacs · **Organisation:** University of Sheffield · **Programme slot:** 16:10-16:20 · **Order:** 6 · **Paper:** 39

DESCRIPTION OF PROPOSED TALK

Introduction and context

The gender health gap shows that while women live longer, they spend 25% more of their lives in poor health (1). To address this, the Women's Health Strategy for England highlights the importance of educating healthcare providers about women's health, however, the authors of this paper believe it is also crucial to educate biomedical engineers to equip them with the knowledge and skills they need to engineer solutions which address the health needs of women (2).

Previous research

Our module entitled: “Women's Health in Biomedical Engineering” was designed based on a previous study which gathered student and educator perspectives on women's health in Biomedical Engineering and the curriculum. The aim of this study was to gather educator and student feedback on the implementation of the module and to share our knowledge and experience with Biomedical Engineering educators from other institutions.

Methodology

The module was delivered to level 4 undergraduate students and MSc students studying Biomedical Engineering between September-December 2025 and the cohort comprised female (n=17), male (n=4) and non binary (n=1) students. Here, we summarise the module content and design and provide both the educator and student perspectives on what was effective.

Findings

The student cohort, who selected this optional module, were highly engaged and contributed substantially to sessions throughout the module. Students and educators both valued the inclusion of diverse guest speakers which included: professionals from healthcare, industry and academia. Student feedback (n=13) collected through an institutional module feedback questionnaire demonstrated 100% positive feedback across all categories. Student's assessed work, in the form of portfolios and an entrepreneurial style pitch presentation, demonstrated that students could identify unmet needs in women's health, implement inclusive engineering skills and communicate their understanding of women's health. Students delivered pitches on diverse topics including: endometriosis and cancer detection, inclusive surgical instrument design and medical devices for hormone delivery and microbiome maintenance.

Impact

The module inspired one student from the cohort to organise a university-wide “Women's Health Innovation Challenge”, bringing together 50 students to solve gaps in women's healthcare. Following the event, it was shown that 86% of participants shifted how they viewed women's health and the winning team subsequently went on to become finalists in a university entrepreneurial competition. This demonstrates how the module's impact extended far beyond the classroom, engaging and inspiring the next generation of engineers and supporting them in their career aspirations.