TO STAGE OR NOT TO STAGE: MAPPING SELF-DEFINED STAGES OF CANCER EXPERIENCE

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Abstract

Most health conditions, such as cancer, are described through medically defined stages that guide diagnosis and treatment. While vital for clinical decision-making, the stages patients actually experience may differ from, or be more complex than, these theoretical models. Long-term conditions such as cancer and chronic diseases involve changes in social roles, relationships, identity, and everyday life—dimensions often overlooked within medical and psychological stages.

Our exploratory study complements medical perspectives by mapping self-defined stages emerging from patients' lived experiences. Using digital ethnography, we analyzed 461 publicly shared Instagram posts from six cancer patients to explore how they articulate and navigate their longitudinal illness journeys. The analysis revealed seven personally meaningful stages, each associated with related coping strategies. The poster visualizes these stages and illustrates how, across individual timelines, patients' experiences did not follow a fixed or linear order. Instead, stages overlapped and fluctuated depending on changing medical and personal circumstances. Transitions were often tied to major medical milestones such as diagnosis, scans, or treatment cycles, but were also shaped by everyday events, family relationships, and emotional shifts.

Building on this work, the next study adopts a co-design approach with cancer patients, survivors, and psychologists. It examines how stakeholders interpret self-defined stages and identifies stage-specific psychological needs, supportive tools, and coping strategies. At TechMed Research Day, we aim to discuss these findings and reflect on the upcoming co-design phase, inviting interdisciplinary perspectives and potential collaboration in patient-centered cancer care.

PREDICTING PEDIATRIC ASTHMA EXACERBATIONS USING AI-BASED SYMPTOM AND TRIGGER EXTRACTION

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Introduction

Pediatric asthma is a prevalent chronic disease characterized by an episodic pattern with potential exacerbations requiring hospitalization. Early identification of symptom and trigger patterns is critical for anticipating exacerbations. Electronic patient records (EPRs) contain valuable information but are often unstructured. Automated extraction of symptom and trigger patterns from unstructured EPRS remains challenging, limiting the large-scale use of clinical notes in predictive models.

Objective

This study aimed to improve asthma exacerbation prediction using an LLM approach to detect and classify symptoms and triggers in clinical notes.

Methods

In this retrospective PREVENT study, 6000 clinical notes were analysed from 2000 pediatric asthma patients from Medisch Spectrum Twente. A subset of 500 notes was manually annotated for key symptoms and triggers. The proposed approach combined two pretrained Dutch LLMs for named-entity recognition (symptom/trigger detection) and assertion classification (presence determination). Evaluation was performed on a held-out test set of 100 notes. Performance was evaluated using accuracy and F1-scores.

Results

The approach demonstrated strong performance, achieving 86% accuracy. Symptom and trigger detection reached a micro F1-score of 0.91 and assertion classification a macro F1-score of 0.91. Performance was highest for wheezing and dyspnea (97% accuracy) and lower for comorbidities (40% accuracy), likely reflecting heterogeneous clinical descriptions.

Conclusion

The proposed approach demonstrates reliable extraction of asthma symptoms and triggers from unstructured Dutch notes. This represents a major step toward automated risk stratification and data-driven asthma management. It forms the foundation for future asthma exacerbation prediction models, enabling earlier risk identification and proactive asthma care.

The effect of total knee asthroplasty (TKA) implant alignment on the patellofemoral biomechanics

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Introduction: Total knee arthroplasty (TKA) is commonly performed in patients with severe knee osteoarthritis (KOA), yet approximately 20% of patients remain dissatisfied following surgery. Implant alignment in TKA plays an important role in restoring knee function. Increasing evidence suggests that a personalized alignment approach is required to account for anatomical variability and diverse functional demands. Previous work has established a workflow for personalized implant alignment, enabling closer reproduction of native tibiofemoral biomechanics. However, the influence of implant alignment on the patellofemoral joint biomechanics remains largely unknown .

Objective: A preliminary study to model the patella and the effect on defining the native biomechanics. The ultimate goal is to investigate the effect of implant alignment on patellofemoral joint kinematics and ligament strains.

Methods: The first step is modelling the knee in a musculoskeletal model with the patella as a six degree of freedom joint. This is approached using a force-dependent kinematic (FDK) patellofemoral joint, which is implemented into both native and TKA knee models using AnyBody modeling system. The next step is to assess the influence of patellar mechanics across a range of implant positions. The outcomes are compared with models excluding the patella and with results from previous research to evaluate the impact of patellofemoral joint kinematics and ligament strains.

Results: We expect preliminary results to indicate that incorporating an FDK-driven patellofemoral joint influences tibiofemoral kinematics.

Discussion: These findings highlight the importance of including patellofemoral joint modelling to better define the native kinematics and ligaments strains, supporting improved surgical planning and functional outcomes in TKA.

IMAGING THE LACTTING BREAST: DIXON MRI FOR QUANTIFYING COMPOSITION CHNGES FOLLOWING MILK EXPRESSION

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Abstract

Introduction
Low or perceived low milk supply is one of the main reasons women stop breastfeeding earlier than intended, yet the physiological mechanisms underlying milk production remain insufficiently understood. Improved insight into lactating breast physiology may enhance support for women experiencing lactation difficulties.

Objectives
This study aims to investigate changes in breast composition following milk expression using MRI and to assess the relationship between these changes and expressed milk volume.

Methods
T2-weighted Dixon breast MRI was performed in 15 lactating women before and after milk expression from one breast using a breast pump. Imaging was conducted on a 1.5T MR scanner with dedicated breast and body coils. Breast composition was quantified by separating water-rich content from adipose tissue using semi-automated image analysis.

Results
We observed a statistically significant positive correlation between the reduction in water volume in the expressed breast and the volume of expressed milk. The expressed milk volume is consistently larger than the reduction in breast water-rich content, suggesting milk synthesis between breast pumping and the second MRI scan. The estimated milk synthesis rate based on the current data ranges from 8 to 56 ml/h, which is consistent with literature values.

Conclusion
This study provides the first MR images of the lactating breast before and after milk expression. The results demonstrate volumetric changes in water-rich content, which reflect milk removal and may offer insights into milk synthesis. These findings enhance understanding of lactation physiology and potentially lead to new strategies to investigate differences between healthy women and those with low milk supply.

SMARTROLL: A SMART, SITUATED PHYSICAL ACTIVITY GUIDANCE SYSTEM FOR STIMULATING FRAIL OLDER ADULTS REHABILITATING AFTER HIP FRACTURE SURGERY

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Introduction

Hip fractures are increasing with the ageing population. Physical activity is essential after hip fracture surgery for faster functional recovery and discharge but is challenging and less motivating for frail older adults due to age-related cognitive and functional decline as well as post-surgery complications. Existing app-based solutions are less capable of engaging them in achieving their daily physical activity goals.

Objectives

In this study, we aimed to explore a non-app-based solution that can motivate and engage patients after hip fracture surgery towards achieving their rehabilitation physical activity goals.

Methods

We conducted field observations in geriatric rehabilitation care and interviews with clinical experts (N=6) and a collaborative design study with trained designers (N=7) and synthesised design themes by thematically analysing the 85 resulting designs. We used the themes emerged to guide the design of potential solutions which were iteratively improved and verified via a focus group session with clinical experts (N=4).

Results

We present SmartRoll, a smart rollator that provides continuous feedback on physical activity in an engaging, motivating, and less cognitively demanding way, based on the emerged design guidelines. SmartRoll consists of three extensions: a smart photo frame, painting and an age-friendly game that are designed towards reducing the cognitive load and increasing the engagement and motivation.

Conclusion

SmartRoll could potentially increase adherence to physical activity goals, contributing to faster functional recovery and discharge amid increasing healthcare strain. Our future work includes a field study to evaluate this.

Smart Inhalers as Early Warning Tools for Acute Exacerbations in COPD – A pilot study

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Introduction

Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) contribute substantially to disease progression and healthcare burden. Identifying early physiological changes preceding exacerbations could facilitate timely intervention. Smart inhalers capture inhalation parameters that may signal impending deterioration of COPD.

Objective

To evaluate whether changes in inhalation parameters (inhalation duration, Peak Inspiratory flow (PIF), inhalation volume) measured by the RS01X smart inhaler are predictive of AECOPD within 14 days preceding an AECOPD.

Methods

In this monocentre observational pilot study, nine patients with COPD used maintenance therapy delivered via the RS01X inhaler over six months. Inhalation parameters were analysed 14 days before AECOPD exacerbation onset, as reported in daily e-diaries. Data were explored using descriptive statistics, visual trend analysis, slope estimation, Mann–Whitney U tests and exploratory generalized estimating equations (GEE).

Results

Five AECOPDs occurred in three participants. A decline in PIF was observed in the pre-exacerbation period, followed by partial recovery post-exacerbation. A significant decline in PIF [0.9L per day; 12-13L over 14 days] preceding exacerbation was observed ($p < 0.01$). Inhalation duration and volume did not change significantly ($p = 0.71$ and $p = 0.21$, respectively).

Discussion

PIF may reflect physiological changes surrounding AECOPD. However, its predictive value within a 14-day window appears limited when considered alone.

Future research should include a larger sample size, longer follow-up, and multimodal approaches—integrating smart-inhaler data with clinical and contextual information—to enhance predictive accuracy.

A NAVIGATION-GUIDED A-MODE ULTRASOUND SYSTEM FOR IMPROVING NON-INVASIVE TIBIOFEMORAL JOINT KINEMATIC ESTIMATION

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Abstract

Accurate measurement of knee joint kinematics is essential for studying musculoskeletal function, yet current imaging techniques are limited by radiation exposure or restrictive setups. A-mode ultrasound with optical trackers offers a safer alternative, but its dynamic reliability remains underexplored. Earlier proof-of-concept showed the method is technically feasible but failed to reproduce the ground-truth kinematic pattern. We argued that it originated from bone-peak misidentification in the one-dimensional A-mode signal. We addressed this by developing an intuitive guidance for A-mode placement. It used B-mode ultrasound to reconstruct bone surface to guide A-mode placement and peak selection, aiming to improve femoral and tibial pose and tibiofemoral kinematics.

A cadaveric leg was CT-scanned and instrumented with optically tracked bone pins as ground truth. During initialization phase, a tracked B-mode probe reconstructed local bone surfaces. A-mode beams were visualized relative to the surface to optimize placement and bone-peak selection. A-mode depths were converted into 3D bone points and rigidly registered to CT-derived tibial and femoral bone models. Tibiofemoral kinematics were computed using a joint coordinate system and filtered using Unscented Kalman Filter framework. Navigation-guided measurements were compared with non-navigated as the baseline.

During cyclic flexion–extension task, the navigation-guided approach achieved joint kinematic RMSE 0.51±0.49° and 0.72±0.97° for adduction–abduction and flexion–extension, 1.00±0.97 mm for medial–lateral translation; distal–proximal and anterior–posterior translations were higher at 2.30±1.60 and 3.70±1.06 mm. Internal–external rotation had the largest error at 4.56±2.52° yet still outperformed non-navigated baselines. Cycle-wise translation and rotation errors remained stable; linear fits showed no significant trends for any initialization strategy, with navigation-guided estimates consistently yielding the lowest errors per cycle. Throughout cycle, bone registration with navigation-guided yielded the lowest RMSE as well.

Across experiments, the navigation-guided approach consistently outperformed the non-navigated baseline. By visualizing A-mode beams directly against B-mode–derived bone surfaces, bone-peak selection becomes a geometrically constrained task rather than a purely signal-driven guess. This stabilizes the full processing chain, from point-cloud generation to pose and joint kinematic estimation. Overall, the findings demonstrate a clear message: accurate initialization at the signal level is essential for reliable ultrasound-based tibiofemoral kinematics.

A LEFT-HEART SIMULATOR REPRODUCING VENTRICULAR TWISTING AND VALVE DYNAMICS FOR CIRCULATORY SUPPORT TRAINING

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Abstract

Introduction

Mechanical circulatory support and cardiac surgery require accurate understanding of left-heart mechanics under dynamic loading conditions. Devices such as extracorporeal membrane oxygenation (ECMO), off-pump coronary artery bypass grafting (OPCABG), and left ventricular assist device (LVAD), require realistic physiological pressure conditions, realistic valve motions, and reproduced ventricular twisting. However, many simulators lack these features thus limiting the opportunities for procedural training and evaluation of technical skills.

Objective

The work aimed to develop a left-heart simulator capable of reproducing physiological ventricular volume changes, functional aortic valve dynamics and arterial compliance using mechanical actuation.

Methods

A hyperelastic elastomer (polydimethylsiloxane) was reinforced with helically orientated fibres to reproduce physiological left-ventricular wall deformation and twisting during cyclic loading. A mechanically actuated system generated controlled ventricular filling and ejection, producing pulsatile flow with pressures cycling from diastolic to systolic levels (70 to 120 mmHg). Downstream arterial compliance was incorporated to enable realistic pressure development. Hydrodynamic testing quantified ventricular volume change, wall deformation, and twisting behaviour across cardiac cycles.

Results

The left-heart simulator could withstand physiological pressure ranges up to 120 mmHg and demonstrated physiological ventricular twisting (between 6 – 18°) and functional aortic valve opening. Similarly, ventricular wall motion was observed mimicking ventricular contractions.

Conclusion

The mechanically actuated left-heart simulator provides proof-of-principle for investigating left ventricular haemodynamics and device-heart interactions, supporting procedural training and development in mechanical circulatory support.

SPATIOTEMPORAL ANALYSIS OF OUT-OF-HOSPITAL CARDIAC ARREST

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Abstract

Introduction
Out-of-hospital cardiac arrest (OHCA) is a leading global cause of mortality, with only about 8% of victims in Europe surviving to hospital discharge. Improving survival largely depends on minimizing the time between collapse and the initiation of resuscitation, including chest compressions and defibrillation. However, the time to defibrillator connection varies widely across neighborhoods and times of day. To date, no studies have examined how these variations unfold across space and time.

Objective
This study aims to characterize the spatiotemporal variation in time to defibrillator connection and its relationship with other factors, such as proximity to emergency medical service (EMS) bases. We demonstrate our models using real-world data from Amsterdam.

Methods
Different techniques with kernel density estimation were employed to illustrate the relationship between incidence and time to defibrillator connection. A spatial regression model was fitted to understand the variation in time to defibrillator connection.

Results
The Amsterdam city center showed the best performance across several indicators, while suburban areas, particularly in the southeast, performed worst. High-incidence areas with long connection times were clearly identified. Early initiation of chest compressions before ambulance arrival was associated with a three-minute reduction in connection time, whereas each additional kilometer from an EMS base added approximately 40 seconds.

Conclusion
These findings can help guide municipal efforts to reduce defibrillator connection times and provide valuable insights for researchers studying spatial and operational factors influencing OHCA response.

MULTIMODAL EVALUATION OF PELVIC FLOOR MUSCLE FUNCTION

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Introduction: Damage to the levator ani muscle (LAM) due to vaginal childbirth, aging, or high BMI can lead to pelvic organ prolapse (POP). Conservative POP treatment with pessaries is successful in approximately 60% of patients and this success is known to be influenced by LAM integrity. However, how LAM function relates to pessary success is poorly understood.

Objective: To assess LAM function differences between women with POP and asymptomatic parous women.

Method: LAM function was evaluated in POP patients with a successful pessary fit (n=17), POP patients with an unsuccessful pessary fit (n=20), and asymptomatic parous women (n=20). Functional LAM measurements included 4D transperineal ultrasound (TPUS) with mean principal strain analysis and vaginal surface electromyography (sEMG) during maximal voluntary contraction. LAM integrity was scored using standardized ultrasound-based avulsion criteria. Non-parametric statistical tests evaluated group differences and strain-sEMG correlations.

Results: No significant differences in strain or sEMG among the three groups were observed. Unsuccessful pessary users showed higher rates of levator avulsions compared to asymptomatic women. A moderate negative correlation between strain and sEMG corroborated the anticipated inverse relationship between muscle deformation and electrical activation during contraction.

Conclusion: Voluntary PFM function remains comparable across groups despite anatomical defects, implying that anatomical integrity may predict pessary success more than muscle function, while LAM function may not always be influenced by LAM integrity. Findings highlight complementary roles of strain and sEMG in functional LAM assessment.

Evaluating muscle contributions to knee joint loading in below-knee amputees: a musculoskeletal modeling approach

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Abstract

Introduction
Below-knee amputees frequently experience pain, instability, and altered gait patterns, which may lead to secondary complications in the intact limb due to compensatory loading. Bone-anchored prostheses (BAPs) offer an alternative to traditional socket prostheses, yet current surgical practice typically uses a "one-size-fits-all" implant placement. This may create suboptimal loading and impair function. These effects can be investigated using musculoskeletal (MSK) modeling, widely used in non-impaired individuals but limited in amputee research.

Objectives
The aim of this study was first to investigate the effect of the below-knee muscles on knee joint biomechanics in terms of joint forces and kinematics, as a preliminary step toward further investigation of implant alignment.

Methods
We utilized a MSK model of the lower extremity in the AnyBody Modeling System. A below-knee amputation condition was simulated by fixing the ankle joint and reducing the force contributions of lower-leg muscles spanning the shank to reflect their absence following amputation. Individual muscle effects were determined by systematically setting their maximum force-generating capacity to zero, enabling assessment of their influence on knee joint reaction forces

Results
Preliminary results showed that reducing the force-generating capacity of the gastrocnemius and soleus produced the largest changes in knee joint reaction forces, while other lower-leg muscles had minimal effect. Gastrocnemius weakness decreased proximal–distal forces by up to 17% and anterior–posterior forces by up to 260%, while soleus weakness increased both force components by up to 25%.

Discussion
Assessing the influence of muscle force-generating capacity on knee joint biomechanics is a key preliminary step toward implant alignment analysis. Identifying muscles that significantly affect knee joint reaction forces establishes a biomechanical baseline for future alignment investigations.

PROVIDING INSIGHT IN RESILIENCE AND RECOVERY BY USING FATIGABILITY AND ITS DEVELOPMENT OVER TIME IN OLDER ADULTS AFTER HIP FRACTURE SURGERY

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Abstract

Introduction/objective

Older hip fracture patients are often frail, complicating their recovery trajectories. Insight into patient's resilience may help getting more understanding in their predicted recovery and adjusting their treatment plan accordingly. This study aims to assess if fatigability, calculated with the Capacity to Perceived Vitality ratio (CPV), at baseline and its development over time, can provide insight into recovery and resilience at hospital discharge.

Methods

In this prospective cohort study, growth modelling was used to test whether there was a change in CPV over time during hospitalization and which covariables were associated with CPV. Subsequently, two logistic regression analyses were conducted to assess the role of CPV as a predictor of mobility at discharge (FAC-score) and hospital complications.

Results

CPV did not significantly change over time (estimate=0.99; 95% CI 0.90-1.10). At baseline, men had a factor 1.6 (p=0.01) higher CPV than women and patients with a pre-fracture KATZ-ADL-score of 0 had a factor 2.1 (p=0.003) higher CPV than patients with a pre-fracture KATZ-ADL-score of 2 or more. The logistic regression models showed that when the intercept of CPV increased, the odds of a dependent FAC-score at discharge (p=0.002) and of developing a complication (p=0.037) decreased.

Conclusion

CPV at baseline had predictive value for mobility at discharge and complications during hospitalization. Furthermore, there was no significant change in CPV over time, and the covariables gender and pre-fracture KATZ-ADL mainly influenced the CPV at baseline. These results contribute to the ability to estimate the degree of recovery at hospital discharge, by using the CPV ratio.

Optimization of acquisition time of Na[^{18}F]fluoride PET/CT in fibrous dysplasia patients

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Introduction:
Fibrous dysplasia is a benign bone disorder that can cause pain, deformities, fractures, and reduced physical function. Na[^{18}F]fluoride PET/CT imaging provides a three-dimensional visualization of bone activity and is increasingly used to quantify disease burden. Recent advances in PET technology have enabled shorter scan durations without compromising on image quality. However, the optimal acquisition protocol for Na[^{18}F]fluoride PET/CT in fibrous dysplasia has not yet been defined. Optimization could reduce radiation exposure, shorten scan time, and lower healthcare costs while maintaining diagnostic quality.

Objective:
Determining the lowest acceptable acquisition time while maintaining diagnostic image quality.

Methods:
Fifteen patients underwent Na[^{18}F]fluoride PET/CT imaging, after which scans were reconstructed to simulate 75%, 50%, and 25% of the original acquisition time. Images were assessed visually and quantitatively using various intensity parameters, image noise, and measurements of affected skeletal volume.

Results:
At 25% simulated scan time, intensity parameters deviated more from the reference scan than the known test–retest variability, while no relevant differences were observed at longer scan times. Noise increased with decreasing scan times, and the measured volume of affected skeleton decreased; however, standardized thresholds for the latter two are lacking. Preliminary visual assessment by one experienced reader showed a preference for longer acquisition times.

Discussion/Conclusion:
Based on the intensity parameters, a reduction in acquisition time of up to 50% appears feasible. However, further research is needed to established standardized image-quality criteria and ensure diagnostic quality is preserved.

ABSTRACT TITLE IN CAPTICALS BOLD

Simone Fani (IT-BE-NR)

Abstract

Objective: Upper limb loss due to traumatic injury or disease poses significant challenges to autonomy, daily function, and workforce reintegration, profoundly impacting overall quality of life. While myoelectric prosthetic hands have the potential to restore dexterity, many users discontinue use due to limited functionality and durability.This manuscript describes the design and rationale of an ongoing clinical trial aimed at addressing these gaps in real-world settings. **Methods**: We searched for completed and ongoing clinical trials on ClinicalTrials.gov to study their structure and their gaps, and then we presented the protocol of our ongoing clinical trial. This protocol outlines a randomized crossover clinical trial enrolling 36 adults with upper limb loss to evaluate two multi-articulated myoelectric prosthetic hands. **Results**: Our review of clinical trials revealed that the unique strength of our design is the integration of standardized laboratory tests, extended daily use, onboard usage data, and validated satisfaction surveys. We provided a detailed description of all design choices and rationale of the ongoing clinical study. **Conclusion**: The comparison between our design and the design of other studies indicates that our design is unique in the integration of biomechanical assessments, real-world usage monitoring, and user-reported outcomes. This clinical trial should be capable of assessing if one specific device design can offer clinically meaningful advantages over another. **Significance**: The design of our clinical trial could inform the design of clinical trials targeting the optimization of prostheses and their acceptance by prosthetic users.

REAL-TIME MRI-BASED TUMOUR TRACKING FOR CLOSED-LOOP ROBOTIC LIVER BIOPSY

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Introduction

Both minimally invasive assessment and treatment of liver tumours requires accurate needle placement, for example for performing a biopsy or targeted ablation. Magnetic resonance imaging (MRI) provides superior soft-tissue contrast compared to other imaging modalities, making it optimal for targeting small tumours in the 10-30 mm range. MRI-guided needle placement in the liver is challenged by limited in-bore access as well as respiratory motion, however, which limits operator access and compromises targeting accuracy.

Objective

To introduce a versatile MR-compatible robotic concept "MAMRI" that enables closed-loop robotic needle alignment with respiratory motion using real-time MRI data.

Methods

Real-time 2D MRI at 6 fps was used to track respiratory motion using optical flow principles. A RNN motion prediction algorithm was applied to compensate for the imaging delay and derive updated target coordinates for closed-loop alignment of the MAMRI robot. In-vitro validation was performed using a moving target to evaluate spatiotemporal accuracy.

Results

Real-time MRI-based localisation achieved a simulated mean tracking error of 2.4 mm (median 1.2 mm). Motion prediction resulted in a mean error of 3.6 mm (median 3.3 mm). The complete end-to-end closed-loop robotic alignment error is currently under experimental evaluation.

Discussion and conclusion

MRI-based tumour tracking supports the feasibility of millimetre-scale closed-loop alignment under realistic imaging constraints. The limited in-bore access often compromises needle trajectories, leading to suboptimal targeting in abdominal interventions. Our robotic approach integrated with real-time MRI-based tracking enables uncompromised access for needle positioning and warrants further development of motion-compensated MRI-guided liver biopsy.

4D Dynamic Contrast-Enhanced Dedicated Breast CT: from phantoms to patients

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DMI-RUMC: Department of Medical Imaging, Radboud University Medical Centre
LRCB: Dutch Reference Centre for Screening

Abstract

Introduction: Four-dimensional dynamic contrast-enhanced dedicated breast CT (DCE-bCT) aims to support breast cancer treatment planning and response monitoring by providing quantitative functional imaging information and whole tumor characterization.

Objective: To optimise the imaging protocol and evaluate the quantitative accuracy of DCE-bCT using physical phantoms, and to apply the optimised protocol in an initial patient study to analyse contrast enhancement patterns within a breast tumour.

Methods: Static phantoms were developed to determine the minimum number of projections required for reconstruction. Then, dynamic phantoms were created to assess the quantitative accuracy of the modality. Subsequently, dynamic 3D-printed tumour phantoms with different clinically relevant intratumoral time-intensity curves (TICs) were developed to demonstrate the modality's ability to distinguish heterogeneous tumour regions. Following protocol optimisation and system validation, a multi-patient study was started. In the first patient analysis, the breast tumour was segmented, and voxel-by-voxel TICs were generated. Colour maps based on peak iodine levels and time-to-peak were created to visualise heterogeneity.

Results: In phantom experiments, the measured peak concentration was 4.88 ± 0.61 mg I/mL, compared with a ground truth of 6.06 mg I/mL. Clinically relevant TICs and tumour heterogeneity were accurately simulated and measured. The patient study revealed heterogeneous tumour enhancement. Distinct regions showed either delayed, lower enhancement, or rapid, higher enhancement.

Discussion/Conclusion: Phantom studies enabled optimisation and validation of DCE-bCT for quantitative functional breast imaging. The initial patient case demonstrates the feasibility of voxel-wise analysis and tumour-heterogeneity visualisation. Future work will investigate relationships between perfusion characteristics, tumour type, and treatment response.

Compression Therapy in Human Body Applications: An Overview from Principles to Practice

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Introduction

Compression therapy is widely used to manage diverse pathologies by applying controlled pressure to the body. However, as existing literature focuses on investigating compression therapy within individual pathologies, it limits cross-pathological synthesis and hampers translation of clinical findings into general design principles for compression devices.

Objective

The aim is to identify cross-pathological insights from a tissue perspective that provide unified principles for compression device design by reviewing and synthesizing literature regarding three elements: biomechanical effects, theoretical models, and characteristics of compression for three representative pathologies, namely Chronic Venous Insufficiency (CVI), edema, and ligament injury.

Methods

A systematic search of Scopus (1990-2025) using four search strings identified studies evaluating compression therapy for the selected pathologies. Search terms include "*Compression therapy", CVI, edema, ligament injury, etc.* Inclusion criteria required quantitative characteristics of applied pressure and reported biomechanical outcomes, or identifying theoretical models directly describing tissue response to pressure. Studies were grouped by pathology and comparatively synthesized to extract shared mechanism and diverse pressure-response relationships.

Results

Seventy-four studies were included (CVI: 9, edema: 18, ligament injury: 25, theoretical models: 21). In CVI, static compression between 15-70 mmHg, depending on venous type and body position, reduced venous diameter by 10-25%. Dynamic compression at 120 mmHg (4 impulses/min) achieved maximum venous pumping effect. In edema, 40-60 mmHg static compression promoted fluid drainage and reduced limb volume by 20%, while 120 mmHg dynamic compression reached up to 40% reduction. In ligament injury, 10-30 mmHg were generally used to improve proprioception and provide about 1.2 N/mm additional stiffness.

Conclusion

Across pathologies, compression therapy operates through a shared biomechanical mechanism: external pressure regulates tissue pressure and stiffness. However, required pressure magnitude and mode (static or dynamic) depend on the therapeutic objective, such as improved venous return, fluid redistribution, or mechanical stabilization. These cross-pathological insights translate clinical goals into engineering design requirements for safe and adjustable compression devices.

Adaptive Control of a Soft Pneumatic Origami Endoscopic Actuator

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Adaptive Soft Robotic Tip for Improved Colonoscope Navigation

Introduction: Colonoscopy remains the standard for colorectal screening, yet navigation through the colon can be challenging due to looping, discomfort, and limited controllability of the passive insertion tube. Conventional colonoscopes rely heavily on manual pushing and operator skill, while only the distal tip provides active steering. Improving the controllability of this active section may enhance navigation safety and efficiency.

Objective: This work proposes a soft robotic active tip designed to improve steering and navigation during colonoscopy by introducing compliant, controllable bending behaviour inspired by soft robotics.

Methods: A three-chamber soft pneumatic origami actuator was developed to replace or augment the conventional active tip. Differential pressurisation enables smooth multi-directional bending. Experimental characterisation was used to identify pressure–bending relationships, which supported workspace analysis and the development of a data-driven adaptive control strategy for trajectory tracking. Real-time tip motion was measured using electromagnetic tracking to evaluate performance.

Results: Experimental studies demonstrated stable bending control and accurate trajectory tracking across a range of configurations. The soft structure enabled compliant motion while maintaining controllability through adaptive feedforward and feedback control.

Discussion and Conclusion: The proposed soft robotic tip addresses key limitations of current colonoscope navigation by enhancing active steering while maintaining compliance. This approach may reduce reliance on pushing forces and support safer, more intuitive navigation. Future work will focus on clinical integration, improved modelling of interaction with anatomy, and validation in realistic environments.

ENHANCING DIALYSIS MEMBRANE HEMOCOMPATIBILITY BY GAGs GRAFTING DURING MEMBRANE FABRICATION

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1. Introduction
End-stage renal disease (ESRD) affects more than 3.5 million people worldwide and is characterized by progressive and irreversible loss of kidney function. Due to the limited availability of donor organs, most patients rely on hemodialysis to survive. However, the filters used in hemodialysis have limited hemocompatibility that leads to protein adsorption and blood clots formation.

2. Objective
This study aims to improve hemocompatibility of filters and dialysis membranes by grafting Glycosaminoglycans (GAGs) onto the membrane surface directly during membrane fabrication, thereby avoiding multiple time-consuming post-modification steps. GAGs are naturally present in the kidney and provide natural anticoagulant properties, preventing blood coagulation.

3. Methods
A bioadhesive molecule (polydopamine) was blended into the polymer solution forming the membrane to simultaneously bind GAGs during fabrication – a concept referred to as 'chemistry-in-a-spinneret'. The fabricated membranes were characterized using material analysis, staining techniques and coagulation assays to verify the presence of GAGs. Water permeability and in-vitro blood experiments were also performed to evaluate the toxin removal efficiency of the membranes.

4. Results
Membranes functionalized with GAGs showed improved hemocompatibility compared to non-functionalized membranes and commercial membranes, while maintaining adequate transport properties.

5. Conclusion
The fabricated membranes demonstrated suitable transport performance for dialysis. Further experiments testing the coagulation response with whole human blood are planned to confirm the improved hemocompatibility.

ESTIMATION OF WORKFORCE ALLOCATION TO DISEASES FOR HOSPITAL-BASED HEALTHCARE PROFESSIONALS

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Introduction: Health systems face persistent workforce shortages; planning requires clear estimates of how much specialist-care capacity is used by specific diseases.

Objective: To develop a scalable method to quantify disease-attributable specialist-care workload and, as a next step, translate it into full-time equivalents (FTE), illustrated with type 2 diabetes mellitus (T2DM).

Methods: We analysed pseudonymised Dutch health insurance claims from the Vektis database (2015–2024). Adults were labelled with T2DM based on medication, general practitioner T2DM care, or hospital diabetes-related diagnosis–specialty codes, excluding type 1 diabetes medication patterns. We aggregated specialist-care activities per person-year and compared T2DM patients to matched non-T2DM controls (1:1 nearest-neighbour matching on age, sex, and calendar year). In parallel, we are implementing a staggered-adoption difference-in-differences design that uses diagnosis timing and not-yet-diagnosed individuals as the comparison group to estimate changes in activity rates immediately after diagnosis. We are also developing an activity-to-time mapping using observed workload patterns, literature-based constraints, and expert input.

Results: In a random subsample of 5 million individuals, approximately 220,000 T2DM individuals per year were matched to controls. T2DM patients had more specialist-care activities than controls (11.4 vs 9.8 per person-year, 2015–2024). The utilisation gap widened from about 11% in 2015 to about 17% in 2024; the largest activity shares in T2DM were cardiology (about 17%) and internal medicine (about 15%).

Conclusion: Claims data can quantify the specialist-care activity burden attributable to T2DM and how it evolves over time. Ongoing work will translate these activity profiles into time and FTE estimates to support workforce planning and assessment of innovations' capacity implications.

One Space, Multiple Perspectives: How Psychiatric Environments Shape Experiences of Stigma and Dignity in Perinatal Mental Healthcare

Carmen Heuvelmans (ET-IXD), Jodi Sturge (ET-IXD), Asli Gunay (ET-IXD), Geke Ludden (ET-IXD)

Abstract

Introduction Psychiatric care environments are not neutral. Their design is shaped by historical practices of surveillance, isolation, and safety-focused care, and continues to influence how mental healthcare is experienced today. These environments can unintentionally reinforce stigma, affecting patients' sense of dignity. While evidence-based design has improved safety and wellbeing, its role in supporting dignity remains underexplored.

Objective This study explores how psychiatric environments shape experiences of stigma and dignity, focusing on differences between the perspectives of perinatal patients and other stakeholders.

Methods A qualitative approach combined insights from a scoping review with data from 26 participatory workshops with perinatal patients and healthcare professionals. Participants identified design features experienced as stigmatizing or dignifying and co-designed alternative design ideas. Data were thematically analysed using Atlas.ti.

Results Findings show differences between the intentions of designers, the perspectives of healthcare professionals, and the experiences perinatal patients. Women in the perinatal period showed specific environmental needs. Safety-focused features such as surveillance cameras were often experienced as stigmatizing. Everyday objects such as wall clocks and toilets, rather than being neutral, were associated with increased rumination and feelings of wasted time. In contrast, windows with changing views and images of mothers with infants were associated with increased feelings of dignity, emotional connection, and empowerment.

Conclusion These findings suggest that design should be approached as a form of medicine, with a clear intention of supporting dignity. By including patient perspectives, these spaces may reduce stigma and support recovery, helping mothers return to their newborns to strengthen mother-child bonding.

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Extended Reality for MRI-Guided Cardiac Interventions: Evaluation on an Anthropomorphic Cardiac Phantom

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Introduction

Performing cardiac interventions such as catheter ablations under MRI guidance offers improved accuracy in a radiation-free setting, potentially reducing re-do rates. The current workflow builds on an in-room 2D display for visualization, combined with intensive team communication to adapt imaging parameters and guide the procedure. Extended reality (XR) may improve this by providing operator interaction and intuitive 3D visualization during catheter navigation.

Objective

To develop an XR tool that improves spatial awareness, enables clinician-scanner interaction and reduces procedural times in MRI-guided cardiac interventions.

Methods

An MRI-guided catheter procedure was simulated using a 3D-printed anthropomorphic cardiac phantom in a 1.5T MRI system (Magnetom Aera, Siemens Healthineers, Forchheim, Germany). The catheter position (Vision-MR 1.0, Imricor, Burnsville, MN) was recorded with an active tracking sequence and rendered within a hologram of the phantom lumen using a head-mounted XR device (Hololens, Microsoft, Redmond, WA). Predefined anatomical views were integrated to enable live imaging for procedural guidance.

Results

XR provided intuitive holographic visualization and hands-free adjustments during MRI-guided catheter interventions. End-to-end display latency was 114 ± 4 ms during catheter tracking and 579 ± 21 ms during live imaging. Initial evaluation by an experienced cardiologist was positive, warranting further workflow studies.

Conclusion

The XR tool allows intuitive in-room 3D visualization, enhancing spatial awareness during MRI-guided cardiac interventions. This approach may reduce communication demands and procedural time. These warrant further user-tests to evaluate workflow efficiency.

Self-supervised learning for Neonatal EEG

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Introduction

Deep learning systems typically depend on large, carefully annotated datasets. In neonatal electroencephalography (EEG), tasks such as seizure detection require experts to mark abnormal activity across many channels, a process that is expensive, slow, and often impractical in routine care. At the same time, hospitals continuously collect large volumes of unlabeled EEG. Leveraging this untapped resource is essential for building scalable and clinically useful AI tools.

Objective

We explore whether self-supervised learning can use unlabeled neonatal EEG to learn transferable representations that support downstream clinical tasks, particularly seizure detection, when only limited annotations are available.

Method

We introduce a self-supervised graph masked autoencoder (GMAE-EEG). Multi-channel EEG has an inherent graph structure: each electrode records local temporal activity, while clinically relevant patterns emerge from interactions between regions. Graph autoencoders are therefore a natural fit for modeling spatial dependencies.

A convolutional neural network-based encoder first extracts temporal features per channel. A graph neural network then integrates information across electrodes. The model learns compact embeddings by reconstructing masked parts of the signal. These embeddings are later fine-tuned using a small labeled dataset.

Results & Conclusions

Although quantitative evaluation is ongoing, preliminary experiments indicate that the learned embeddings are stable, physiologically plausible, and improve data efficiency. Compared with training from scratch, fine-tuning the pretrained model converges faster and yields better discrimination in low-label settings. This suggests that self-supervised graph-based pretraining is a promising strategy for neonatal EEG analysis, enabling practical use of abundant unlabeled recordings while reducing reliance on expert annotation.

AUTOMATIC SEGMENTATION AND BLOOD FLOW ESTIMATION IN ABDOMINAL AORTIC ANEURYSMS

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Introduction - Computational fluid dynamics (CFD) is increasingly applied to quantify patient-specific hemodynamics in abdominal aortic aneurysms (AAA). Flow-derived metrics such as time-averaged wall shear stress (TAWSS) may provide functional insight beyond anatomical imaging. However, the impact of geometric modeling, particularly including distal branches, remains unclear.

Objective - To evaluate the impact of including distal iliac branches on CFD-derived metrics in AAA patients by comparing partial and complete aorto-iliac reconstructions.

Methods - In 89 AAA patients, automatic segmentation was used to generate two patient-specific geometries per case: (1) a full model including the abdominal aorta and common, internal, and external iliac arteries, and (2) a partial model excluding the internal and external iliac arteries. Standardized steady-state CFD simulations were performed, and TAWSS, relative residence time (RRT) and oscillatory shear index (OSI) were extracted for all anatomical segments.

Results - Partial geometries showed significantly lower TAWSS in the infrarenal aorta (0.16 ± 0.06 vs 0.19 ± 0.09 Pa, p<0.001) and at the aortic bifurcation (0.34 ± 0.23 vs 0.48 ± 0.29 Pa, p<0.001) compared to the full geometry. Effects in the common iliac arteries were modest. In contrast, suprarenal TAWSS was slightly higher in partial models (+6%, p<0.001). RRT increased markedly in the infrarenal aorta (+51%) and aortic bifurcation (+87%) when distal branches were excluded

Conclusion - Segmentation extent significantly affects CFD-derived hemodynamic metrics in AAA. Exclusion of distal iliac branches alters upstream flow and may bias hemodynamic assessment, highlighting the need for standardized geometric reconstruction in clinical CFD applications.

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Dissolvable Sugar-Based Untethered Magnetic Robots Enabling X-Ray-Guided Navigation in Three-Dimensional Vascular Environments

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Introduction

Current treatment options for thrombus removal include catheter-based interventions and pharmacologic therapies.

However, these antithrombotic interventions carry inherent risk, such as those associated with invasive procedures, sustained access-site and internal bleeding, and drug-related side effects. Also, current limitations include size-restricted reach and navigability of catheters, and the lack of targeted drug delivery options.

Developing biocompatible, drug-loaded, soluble untethered magnetic robots (SUMRs), capable of delivering drugs through intravascular navigation and degradation, might form a method addressing some limitations while mitigating risks.

Objectives

To present the feasibility of SUMRs, we focus on the characterisation of a selection of key aspects: solubility, navigation, localisation. The SUMR should dissolve quickly, and while decreasing in size during navigation towards the target site, should still allow for controlled locomotion. Simultaneously, adequate contrast on X-ray fluoroscopy should be maintained for potential automatic localisation.

Methods

UMRs with screw-shaped geometry were fabricated from a sucrose-alginate composite. Embedded superparamagnetic iron oxide nanoparticles enabled magnetic actuation and X-ray visibility. Navigation capabilities were characterised by swimming through vessel phantoms, including a complex cerebral system.

Results

UMRs could be actuated against physiological flow of 32 mL/min for a duration of 300 seconds, about 90% of their total dissolution time. During this period, the object remained visible on X-ray with a sufficient contrast-to-noise ratio.

Conclusion

We present initial steps for SUMRs to be applicable in a clinical setting. Reliable navigation through a complex environment with physical flow was shown. This will allow local drug delivery, while being localised in real-time on X-ray fluoroscopy.

MULTI-HOSPITAL GENERALIZABILITY OF A PAEDIATRIC ASTHMA DETERIORATION AI-MODEL

Maartje Kuperus (EEMCS-EE-BSS, MST)

Introduction
Pediatric asthma is common with symptoms often presenting in episodes of deteriorations, caused by numerous triggers. The impact of these deteriorations could be reduced by understanding their patterns. Therefore, Medisch Spectrum Twente (MST) developed an AI-model for predicting paediatric asthma deterioration and identifying personal risk factors. Such prediction models are popular but their development on specific populations impairs generalizability. External validation of the MST-model on other populations is now possible through collaboration with Deventer Ziekenhuis (DZ) and Ziekenhuisgroep Twente (ZGT).

Objective
This research aimed to explore the generalizability of the model for predicting paediatric asthma deteriorations on different patient populations.

Methods
The PREVENT study collected demographic and clinical parameters retrospectively over 5 years from electronic patient records of MST, DZ, and ZGT for population comparison. Model performance, sensitivity and F1-score, and feature importance were analysed in different configurations. Performance was assessed using hospital-specific sets, cross-hospital sets, and a held-out test set from the combined cohort.

Results
Analysis of the three populations in MST (n=895), DZ (n=977) and ZGT (n=793) showed small differences across clinical and demographic parameters. No definitive results of the generalizability are available yet. Preliminary analysis showed 5% decrease in sensitivity when using cross-hospital sets.

Conclusion/discussion
Patient populations showed small differences, likely resulting from different care focuses and reporter bias. Preliminary analysis indicate that either hospital-specific sets or a held-out test set from a combined cohort manifest best model performance. This work is an important step toward enhancing model generalizability which might improve asthma management.

THE ANATOMICAL EFFECT OF ROBOT-ASSISTED SACROCOLPOPEXY ASSESSED WITH UPRIGHT MRI

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Abstract

Introduction:
Robot-assisted sacrocolpopexy (SCP) treats pelvic organ prolapse (POP) of the bladder and vaginal vault (VV) or uterus. The effect of SCP surgery relies on the insertion of a mesh, to keep the prolapsed organs in place, by providing new mechanical support. While previous research has investigated pelvic anatomical changes after robot-assisted ventral mesh rectopexy (RVMR) using upright MRI, the biomechanical behaviour and lifting capacity of the finer lightweight gynaecological mesh used in SCP remains unclear.

Objective:
The aim of our study is to assess the effect of SCP surgery on the pelvic anatomy using supine and upright MRI.

Methods:
A total of 9 female patients with POP of the bladder and/or VV or uterus were included from the outpatient clinic in Ziekenhuisgroep Twente. Patients were scanned using a 0.25T tilting MR-system (G-scan Brio, Esaote) before and 6 weeks after SCP surgery. The surgical effect was analysed by measuring the distance of the bladder and VV to a reference line (PICS) using 3D slicer and MATLAB.

Results:
On pre-surgery scans the median distance to the reference line of the bladder and VV or uterus was 44mm below and 10mm above, respectively. After surgery a median lift of the bladder and VV was seen, with 33mm and 44mm respectively.

Conclusion/Discussion:
Preliminary results show that the lightweight mesh used in SCP provides significant lift of the bladder and vaginal vault. The next steps are to analyse one-year follow-up data, determine position and orientation of the mesh as well as a dedicated comparison to the rectopexy data.

Performance prediction of magnetic robots for non-invasive brain treatment

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Introduction

The navigation and control of untethered magnetic robots (UMRs) within the tortuous, soft environment of brain tissue rely critically on their capacity to maintain synchronized rotation with their externally applied rotational magnetic field. The step-out frequency, the fundamental upper limit of this synchronization, dictates maximum propulsion efficiency and system stability.

Objective

We develop empirical models to predict the step-out frequency of UMRs operating in ex vivo brain tissue with viscoelastic properties mimicking the in vivo environment. Leveraging Buckingham Pi dimensional analysis, a minimal set of dimensionless parameters were identified that encapsulate UMR geometry and tissue mechanical behaviour, allowing for performance prediction in biological tissue.

Methods

Step-out frequencies were experimentally measured for four UMR designs embedded within gelatine-based phantoms with tuneable viscoelastic properties. An empirical model was derived from these measurements. To validate its biological relevance, the step-out frequency of a representative UMR was also measured in resected ex vivo ovine brain tissue.

Results

In gelatine phantoms, spiral-type UMRs exhibited an exponential decline in step-out frequency with increasing viscoelasticity. Prediction error across designs ranged from 9% to 36%. The model accurately forecast the operational range of step-out frequencies enabling successful navigation through ex vivo brain tissue.

Conclusions

The derived relationship enables rapid, single-point calibration for estimating UMR performance limits, facilitating efficient design and actuation optimization. This framework provides a critical foundation for advancing magnetic microrobots toward clinical deployment in neurosurgical and therapeutic applications within biological soft tissue.

INTERFACIAL-TENSION-INDEPENDENT MICROFLUIDIC PLUME GENERATOR FOR HIGH-THROUGHPUT, PROGRAMMABLE LIQUID COMPARTMENT PRODUCTION

Lin Chen (TNW-BET-DBE), Tim Segers (EEMCS-EE-BIOS), Claas Willem (ET-TFE-FM2), Jeroen Leijten (TNW-BET-DBE)

Abstract

Background & Objective

Microfluidic droplet-generation systems can monodispersely produce sub-microliter droplets with numerous applications in chemistry, engineering, and health. Conventional approaches essentially rely on interfacial tension–driven pinch-off for their conventional droplet formation, which imposes fundamental constraints on production throughput, surface curvature manipulation, droplet shape, and emulsion formulation. Overcoming these limitations is anticipated to drastically expand microfluidic applications, including enabling transition from laboratory to industry scale production.

Methods

We here introduce microfluidic plume generator (MPG), an interfacial-tension-independent microfluidic system that on-chip produces micro- to nano-scale hierarchical liquid compartments. By applying a resonant acoustic field to the first flow chamber, we established liquid oscillation at the inlet tip, which induce periodically varying inertia force. Combining with the dragging force produced by secondary flow, liquid compartments could be produced independent of interfacial tension.

Results

Specifically, this approach produced monodisperse, compartmental, structure configurable, which included droplets, curvature shapable fibers, and particles with diameters of 5 to 50 µm at a rate that was 1000 times higher than interfacial-tension-driven droplet microfluidics. Furthermore, MPG uniquely enables fibers and particles production from fully miscible flows, i.e., miscible all-aqueous phases. MPG is cytocompatible, as demonstrated by ultra-fast producing of single cell-laden microgels with diverse crosslinking strategies for multiple cell types.

Conclusion

Interfacial-tension-independent MPG therefore establishes a high-throughput, cytocompatible, and structurally programmable droplet generation paradigm, which enables laboratory-to-industry translation of droplet microfluidics.

Layman's version (translated by AI):

Background

Tiny droplets are widely used as miniature test tubes for chemical and biological experiments. Special devices called droplet microfluidic droplet generators can make extremely small droplets by injecting one

liquid in another liquid that does not mix with it. These systems are powerful as they hold the potential to create vast amount of individual droplets , allowing many experiments to be carried out quickly and efficiently.

Objective

Current droplet-making technologies rely near-exclusively on surface tension, the same force that helps water form beads on a surface. However, this approach limits how fast droplets can be produced, how their shapes can be controlled, and whether droplets can be made entirely from water-based materials, which often is needed for medical and biological applications.

Methods

To solve these problems, we invented and patented a new device called a microfluidic plume generator (MPG). Instead of relying on surface tension, this device uses sound waves to reversibly flow liquid through a small opening, which forces that liquid to gently but rapidly break into tiny, controlled droplets or other structures. Moreover, guiding the fluid flow helps shape and guide the process.

Results

Using MPG, uniform droplets, fibers, and particles can be produced in sizes ranging from 5 to 50 micrometers at production speeds that are 1,000 times faster than traditional methods. This novel technology can also produce structures using combinations of liquids that normally cannot be used to produce droplets, which includes fully water-based systems. This is extremely useful for enabling mass clean production of droplets and micromaterials. Importantly, our process is safe for living cells and can mass produce living microtissues that are suitable for various medical applications.

Conclusion

Overall, MPG provides a faster, cleaner, more flexible, and cell-friendly way to mass produce tiny liquid compartments. This new approach may help move droplet-based technologies from research laboratories into large-scale industrial and medical applications.

A Light-Actuated Inchworm Robot Designed for Future Endoluminal Navigation

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Abstract

Introduction

Light-responsive functional materials enable remotely controllable, scalable soft actuators. Among them, liquid crystal elastomers (LCEs) offer programmable and efficient photo-actuation. Yet, most light-driven platforms still depend on direct line-of-sight illumination with limited optical penetration, which constrains deployment in deep-seated and obstructed environments. These limitations are particularly relevant for future applications in biologically and clinically relevant conditions (e.g., endoluminal operation).

Objective

Waveguide-based photoactuation leverages the synergistic coupling between light-responsive materials and flexible optical waveguides, leading to systems that can exploit the optical energy already delivered to deep-seated and obstructed anatomical regions during light-based medical procedures. However, current platforms integrate these materials only at the waveguide tip, limiting functionality. Here, wavelength-selective LCE films are integrated with a tailored side-emitting optical fiber (SEOF) which redistributes optical energy to enable controllable light-driven locomotion of a soft robot along its surface.

Methods

The system comprises a kirigami-engineered 3D cylindrical architecture obtained by laser cutting and folding LCE films functionalized with two photo-absorbing dyes. This design permits wavelength-selective responsiveness and amplified out-of-plane deformation of the individual functional components. It features a three-segment structure, two anchoring components, which allow its extremities to sequentially lock around the SEOF, and a central linear actuator that contracts to ensure translocation.

Results and Conclusion

By employing a multi-wavelength LED light source to apply programmed temporal illumination patterns across selected wavelengths, the system achieves controllable, inchworm-like propulsion. Because the actuation energy is guided within the SEOF, the platform achieves line-of-sight-independent locomotion, opening pathways for future biomedical applications such as targeted drug delivery, minimally invasive tissue manipulation and localized phototherapy.

IMPROVING THE MALIGNANCY RISK ASSESSMENT OF THYROID NODULES WITH PHOTOACOUSTIC IMAGING: AN IN VIVO STUDY

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Introduction: The incidence of thyroid nodules has been rapidly increasing due to increased detection through imaging. All nodules require malignancy assessment, as 10-15% of them are malignant. The standard imaging modality is ultrasound (US). However, the specificity of US is low, which leads to a high number of unnecessary fine-needle aspirations (FNA) and diagnostic surgeries. Photoacoustic imaging (PAI) can be a promising add-on technique to the standard US to rule out malignancy with more certainty and reduce the number of invasive diagnostic procedures.

Objective: The objectives are to investigate the diagnostic value of PAI and determine how the technique can be optimised to improve its diagnostic performance.

Methods: In a two-centre study (a collaboration between ZGT Hengelo and University Medical Centre Groningen), up to 150 patients with a thyroid nodule for which there is an indication for FNA will be included. Before FNA, patients will undergo PAI with the Imagio system. The system's ability to visualise the relative tissue oxygen saturation and patterns in the blood supply around the nodule will be utilised to determine if these characteristics can aid in distinguishing between malignant and benign nodules. The PAI results will be compared to cytology and/or histopathology results from the FNA or diagnostic surgery.

Significance: We aim to show that PAI can be a valuable additional technique to improve the malignancy risk assessment for thyroid nodules. It would reduce the number of unnecessary invasive diagnostic procedures, and it would greatly alleviate the psychological burden on patients and their loved ones.

PHYSIOLOGICAL JOINT COUPLINGS IN ACTIVITIES OF DAILY LIVING TO SUPPORT MINIMAL UPPER LIMB ASSISTIVE DEVICE DESIGN

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Introduction
Neuromuscular diseases, such as Amyotrophic Lateral Sclerosis (ALS), lead to loss of muscle control. Reduced muscle functionality limits independence in Activities of Daily Living (ADLs), such as eating. Upper limb assistive devices, including exoskeletons, can help maintain autonomy. However, many devices aim to support all anatomical degrees of freedom, resulting in bulky, heavy, and complex systems that reduce comfort, ease of use and user acceptance. An alternative is to support only essential degrees of freedom required for ADLs, enabling lighter and intuitive designs.

Objective
This study aims to identify coupled joint motions present during ADLs to determine the essential degrees of freedom for an individual to perform ADLs.

Methods
The 'Motion-Capture Data for Robotic Human Upper Body Model' dataset was analysed containing ten participants performing various ADLs. Correlation between joint angles were calculated. When present, several computational upper limb models were developed using these couplings. The optimal performing model was chosen using an optimisation approach favouring human-like movement and performing the closest hand trajectory as offered by the reference model. The compensatory joint movements required to achieve this trajectory were determined as a measure of increased effort for the user compared to the uncoupled reference model.

Results
The outcomes provide an overview of relevant joint couplings during ADLs along with a scoring based on required effort. Coupling elbow flexion and forearm supination required 22° of compensatory shoulder rotation during eating.

Conclusion
These results support development of lightweight and user-friendly devices to improve usability for individuals with reduced muscle strength.

SIMULATING SCATTERING BY RED BLOOD CELLS USING IN-HOUSE DEVELOPED MAXWELL SOLVER

Swapnil Mache (TNW-BIS-BMPI), Ivo M. Vellekoop (TNW-BIS-BMPI)

Objective
Studying the light scattering properties of blood is crucial for medical research and applications such as photoplethysmography and laser speckle (contrast) imaging. Our goal is to contribute towards their understanding through numerical simulation of the interaction of light with flowing blood. Therefore, we simulate 3D microscopic light scattering on red blood cells (RBCs) in blood vessels up to 1 mm. This problem is computationally exceptionally large: such simulations would either require weeks or are completely out of reach of current state-of-the-art and commercial solvers.

Methods
We can simulate such large 3D domains using our in-house developed solver, currently the fastest to solve Maxwell's equations. We also leverage our recently developed domain decomposition framework, which enables us to split the computations over multiple graphics processing units (GPUs). Our solver is accurate, memory efficient, guarantees monotonic convergence, and is exceptionally suited to structures with low scattering contrast like RBCs in plasma. We leverage our solver's memory efficiency and speed for this computationally large problem, with a representative model of RBCs suspended in plasma, considering their distribution, orientation, and deformation.

Discussion
With our solver, we simulated light propagation through a collection of small spheres of an unprecedented $3.28 \cdot 10^7$ cubic wavelengths (sampled at 4 points per wavelength), or $2.1 \cdot 10^9$ voxels, in just 45 minutes on two GPUs. By demonstrating simulation of scattering by RBCs in blood flow in large 3D domains, we expect to open opportunities for studying, at millimetre scale, the scattering properties of not just blood, but biological tissue in general.

DEVELOPMENT OF ARTIFICIAL ERYTHROCYTES FOR USE IN MEDICAL DEVICE TESTING AND TRAINING SIMULATORS

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Abstract

Objective

We propose an innovative approach to fabricate artificial erythrocytes via in-air microfluidics to be applied as artificial blood in device testing and training simulators. On the one hand, in-vitro verification of medical devices (e.g., oxygenators) relies on animal-blood testing. However, these tests are limited by blood availability, shelf life, and differences between animal and human blood. On the other hand, extracorporeal life support (ECLS) training simulators are increasingly utilized to train medical professionals. However, no dedicated fluid is available to simulate red blood cell functions in such models.

Methods

Our artificial erythrocytes aim to meet four requirements: 1) O_2 transport similar to human erythrocytes, 2) prevent CO_2 accumulation, 3) use biocompatible materials, 4) sufficient small size to be transported inside medical devices (50 – 100 μm). Different oxygen carriers and shell materials are being evaluated. Artificial erythrocytes were fabricated by in-air microfluidics applying a core-shell nozzle capable of jetting multi-materials. Break-up of a compound liquid jet formed uniformly sized droplets that were solidified in air. Collected capsules were evaluated for artificial erythrocytes application.

Results

Artificial erythrocytes containing α-cyclodextrin as O_2-carrier and a polymer shell were produced consisting of 265 μm ± 5.2 μm capsules being mostly monodisperse in size. The in-air microfluidic system allowed tuning of capsule size and fabrication of ~2000 erythrocytes/s. Currently, the nozzle design is being optimized for capsule downsizing.

Conclusions

Capsules comprising a polymeric shell and an O_2-carrying fluid core were fabricated via in-air-microfluids. This is a first step towards artificial erythrocytes for use in medical device testing and simulators.

HYBNETIC: A MOBILE HYBRID MAGNETIC ACTUATION SYSTEM

Lukas Masjosthusmann (ET-BE-SRL), Nicholas R. Posselli (ET-BE-SRL), and Sarthak Misra (ET-BE-SRL)

Abstract

Motivation
Magnetic actuation enables contactless control of medical microrobots and instruments and offers the potential for improved safety and effectiveness in robot-assisted minimally invasive surgery. While much research is being conducted on the development of surgical devices, there is a lack of external actuation systems that provide the necessary magnetic field shaping capability for *in vivo* control. Existing magnetic actuation systems often face trade-offs between field shaping capability and workspace size.

Methods
In this work, we introduce HybNetic, a mobile hybrid magnetic actuation system that combines a single electromagnet with four independently rotatable permanent magnets mounted on a robotic arm. The C-shaped configuration of HybNetic has an opening of 520 mm, allowing positioning around the human torso. The mobility of the employed robotic arm extends the effective workspace to the length of a human body.

Results
We describe the design and field modeling and characterize the magnetic performance by comparing analytical model predictions and finite element simulations with experimental validations. Finally, we demonstrate the versatility of HybNetic by levitating a magnetic sphere and navigating a magnetic guidewire through a dimensionally accurate phantom of the abdominal aorta.

Conclusion
The demonstrations highlight the potential of HybNetic as a magnetic actuation system with a workspace that is suitable for *in vivo* manipulation of magnetic devices.

MODELLING OF THE HUMAN-EXOSKELETON INTERACTION INTERFACE: CURRENT AND FUTURE APPROACHES

Masselink, Lisette (ET-BE-NR), *Refai, Irfan (ET-BE-NR)*

Introduction

The complex interaction between human and exoskeletons poses a big challenge for implementation of exoskeletons in real life. The interaction interface, represented by the human soft tissue and the attachment of the exoskeleton, affects the force and motion transmission from exoskeleton to human. Therefore, the interaction interface influences the amount of assistance for the user.

Objective

This review provides an overview and future directions of the modelling of the human-exoskeleton interface.

Key findings

Interaction models use different level of complexity, ranging from idealized force representations to inclusion of the movement and soft tissue effects at the interface. The shift from rigid to soft exoskeletons increases complexity of these models. The simplified models do not account for the power loss at the interaction interface, whereas the captured soft tissue behaviour of complex models should be validated.

Challenges

Main interaction insights are gathered from indirect data, such as inverse dynamics. Therefore, models should be validated using sensorized phantoms and human experiments to capture the forces at the interface. Moreover, modelling the soft tissue, the straps and the contact dynamics affects the speed of the simulations, limiting its usage for design and evaluation of the interaction interface.

Future direction

Data from the human-exoskeleton interaction interface could accelerate the models into learning-based models. Reinforcement learning could be used to find the optimal attachment and the assistance profile for an exoskeleton. Moreover, computer vision could estimate interaction measures from motion capture. This allows for improved design and of the exoskeleton, increasing comfort and efficiency.

Context-Informed Myoelectric Control of Lower-Limb Assistive Devices During Gait Using a Low-Cost Wearable Armband

Rami Mobarak (ET-BE-NR)

Abstract

Lower-limb motion intention decoding is important for natural human–robot interaction in medical and industrial settings. Surface electromyography (sEMG) signals can predict movement well, but performance often drops in practical systems. While deep learning models improve accuracy, they are usually too computationally demanding for low-cost microcontrollers. This study introduces two lightweight context-informed feature extraction methods, i.e., Myoelectric Temporal Patching (MTP) that captures distinctive temporal patterns, and WaveLSTM, that capture consider spatiotemporal patterns, yet both remaining suitable for embedded devices. Using shank sEMG data collected with the Myo Armband during walking, both methods outperformed traditional features and standard deep learning models for three-class gait-phase recognition. MTP achieved the optimal performance, reaching 88.2% average accuracy offline (20 subjects) and 79.4% online (4 subjects). The findings suggest that temporal information alone provides strong discriminative power for lower-limb tasks. These methods offer deep-learning level performance with much lower computational cost, supporting real-time implementation on microcontrollers. An open-source dataset and framework are also provided to encourage reproducibility and adoption.

TOWARDS AN UPSCALED BIOARTIFICIAL KIDNEY DEVICE

<u>Elham Nasseri (TNW-AOT)</u>, Odyl ter Beek (TNW-AOT), Dimitrios Stamatialis (TNW-AOT)

Introduction

End-stage kidney disease patients rely largely on dialysis due to donor shortages. However, dialysis replaces glomerular filtration only but lacks essential tubular functions. This leads to toxin accumulation, reduced quality of life. These limitations highlight the need for improved therapies.

Objectives

This study aims to develop and upscale in vitro bioartificial kidney device consisting of living membranes . In this system, proximal tubular cells are cultured on commercial polymeric hollow fibers to form functional kidney tubules. This approach moves the design toward a more biomimetic and clinically relevant configuration.

Methods

Upscaling is achieved by modification of commercial as well as fabricating custom hollow fiber membranes with controlled geometry and transport properties. The fiber lumen is biofunctionalised, and conditionally immortalized human kidney proximal tubular epithelial cells (ciPTECs) are seeded there to form uniform monolayers. This configuration promotes a more biomimetic geometry, higher packing density, and improved cell protection.

Results

Commercially available fibers were mechanically stretched to obtain reduced diameters. In parallel, high-flux polymeric hollow fiber membranes with tunable diameters were fabricated by spinning. The lumen was biofunctionalised using dynamic coating, after which ciPTECs were seeded to form uniform cell monolayer.

Conclusion - outlook

These developments establish a foundation for culturing renal tubular cells within hollow fiber membranes. Next, cell monolayers will be evaluated for key physiological tubular functions and transport of protein-bound toxins.

A UNIFIED DEEP LEARNING WORKFLOW FOR TEMPORAL BONE SEGMENTATION OF PETROSUM CT-SCANS FOR EAR CANAL WALL IMPLANT RESEARCH

Javier Perez y Perez (ET-BE-EOST/MST), Frank Halfwerk (ET-BE-EOST), Jelmer Wolterink (EEMCS-AM-MIA), and Feddo van der Beek (MST)

INTRODUCTION: Current deep learning segmentation algorithms of petrosum CT-scans often omit the air-containing regions of the ear (e.g. the external auditory canal and middle ear cavities). Many applications (e.g. 3D-printing) prioritise bone and soft-tissue segmentation. A comprehensive temporal bone segmentation workflow including the air-containing regions of the ear will support current ear canal wall implant research.

OBJECTIVE: To combine existing algorithms into one workflow that semi-automatically reconstructs anatomically accurate three-dimensional (digital) temporal bone models, including air-containing regions of the ear.

METHODS: With institutional board approval (PaNaMa id:1320), 92 clinical petrosum CT-scans from MST in patients with suspected cholesteatoma were obtained. Deep learning algorithms from Erasmus MC and Western University produced initial labels for the temporal bone. An MST region growing algorithm produced those labels for the external auditory canal and middle ear cavities. Experts reviewed these labels to form reference labels. A nnUNet model was trained using fivefold cross validation without an external test set. Segmentations were converted to virtual three-dimensional models in 3D Slicer. One ENT-surgeon and one radiologist from MST qualitatively assessed anatomical correctness in a digital environment.

RESULTS: The combined workflow produced labels for the temporal bone, the external auditory canal, and middle ear cavities with discrimination of critical anatomical structures that both experts deemed accurate.

CONCLUSION: This study created one workflow that combines existing algorithms that can segment full temporal bone anatomy from clinical petrosum CT-scans and generate digital models that include the external auditory canal and middle ear cavities.

Assessing the function of the pelvic floor muscles based on ultrasound - Does it work?

Selena H.J.M. Peters (TNW-M3i), _Irina De Alba Alvarez (TNW-M3i), Anique T. M. Grob (TNW-M3i), Claudia Manzini (TNW-M3i), Jaimy A. Simmering (TNW-M3i)_

Abstract

Background The puborectalis muscle (PRM) plays a significant role in maintaining continence and supporting pelvic organs. Transperineal ultrasound (TPUS)-based strain measurements offer insight into PRM function, which can be derived using an in-house developed software program that relies on manual segmentations. This study investigates the reliability and reproducibility of PRM strain assessment and the influence of manual segmentations.

Method Four-dimensional TPUS recordings were obtained of women with and without pelvic floor disorders. The PRM was manually segmented in a resting frame by two observers (3D Slicer), following a validated protocol. Inter-observer agreement for the PRM segmentation was determined using the Dice Similarity Coefficient (DICE). Strain results consisted of principal component strain values, strain pattern plots, and strain magnitude plots, which were compared across segmentations for each participant.

Results Nineteen cases were analyzed. Inter-observer comparisons revealed variation in the thickness and length of the manually segmented PRM (DICE 0.15-0.70). Principal component strain values varied between 0 and 9%. Thirteen cases (32%) demonstrated a similar strain pattern for both observers. No correlation was found between the DICE score and the differences in strain obtained.

Conclusion This study demonstrated that consistent strain patterns can be seen, despite variability in manual segmentations. Although the observed consistency in strain patterns suggests that the software may be robust to segmentation variability, the current data does not allow for definitive conclusions regarding its robustness. The clinical relevance of principal component strain remains uncertain, as measurements performed by two independent observers showed variability.

DECIDING ON PATIENT ADMISSION IN AFTERCARE

Chris Petri (EEMCS-AM-MOR), Anne Zander (EEMCS-AM-MOR), Daniela Guericke (BMS-HBE-IEMS), Richard J. Boucherie (EEMCS-AM-MOR)

Background
The greying population in the Netherlands is causing increasing pressure on healthcare services. While the demand for care is projected to grow, the estimated number of available healthcare staff is not increasing at the same pace. This pressure will become particularly visible in aftercare (VVT), such as nursing homes or rehabilitation facilities. Capacity shortages in VVT delay hospital discharges, which negatively affects patients, organisations, and healthcare staff.

Objective
Our main focus is to align patient discharge from hospitals with admission to VVT, to effectively utilise available VVT capacity. We aim to support VVT facilities in their decision of how many patients can be safely admitted, while limiting the risk of work overload for staff. Additionally, we explore how flexible resources, e.g., staff and beds from other wards, can be reallocated to better respond to unforeseen fluctuations in demand.

Methods
With current hospital bed occupancy data, we estimate short-term patient outflow from hospitals to VVT. Using these forecasts, combined with current bed occupancy data and projected available staff in a VVT facility, we develop an algorithm that suggests risk-averse decisions that maximises patient admissions, while limiting the magnitude and duration of work overload for staff.

Expected Outcomes
We aim to develop a decision support tool that helps aftercare facilities decide on patient admissions and improve coordination with hospitals. This research is expected to provide insight into managing patient flow and capacity planning under uncertainty, enabling efficient use of available resources while reducing the risk of staff work overload in VVT.

TechMed Research Day, 16 April 2026

IN SILICO EXPERIMENTATION ALLOWS OPTIMIZATION OF PHOTOACOUSTIC IMAGING HARDWARE FOR THYROID NODULE RISK ESTIMATION

Max Rietberg (TNW-BIS-M3i), Jelmer Wolterink (EEMCS-AM-MIA), Srirang Manohar (TNW-BIS-M3i)

Introduction
Thyroid nodules are highly prevalent but have a low malignancy rate. Ultrasound (US), the first-line imaging modality for thyroid nodule evaluation, stratifies nodules based on their ultrasound characteristics to estimate malignancy risk. However, these features alone do not provide sufficient specificity to rule out thyroid cancer. Consequently, invasive diagnostic procedures are often required.

Objective
Photoacoustic imaging (PAI) integrates optical absorption contrast with ultrasound detection, enabling quantification of functional features, like vascular architecture and blood oxygen saturation (SO_2). Incorporating PAI into conventional US imaging may therefore improve diagnostic specificity. Recent works have demonstrated the added value of PAI by extracting SO_2-based features in a thyroid nodule US+PAI study. However, current PAI hardware setups are not optimized for thyroid nodule risk estimation.

Methods
We evaluate the performance of 1080 variations in a PAI hardware setup, using a digital phantom and numerical simulations. The investigated hardware characteristics include illumination placement, transducer array shape and optical wavelength. Performance is assessed by quantifying target SO_2 estimation accuracy and target detectability.

Results and Conclusions
We show that illumination placement strongly affects performance, with endotracheal illumination emerging as a promising approach. Additionally, curved transducer arrays substantially increase average target detectability compared to linear arrays. Furthermore, for external illumination, a wavelength combination of 757+800 nm yielded the highest accuracy in target SO_2 estimation, whereas for internal illumination, this is using 700+1064 nm. After validations, these recommendations could help with the optimization of PAI hardware for risk estimation of thyroid nodules and reduce need for invasive diagnostic procedures.

TechMed Research Day, 16 April 2026

DEVELOPMENT OF OUTSIDE-IN FILTRATION HOLLOW FIBERS FOR ARTIFICIAL PLACENTA SYSTEM

Lucia Romano (TNW-AOT), R.Luiten (TNW-AOT), O.E.M. ter Beek (TNW-AOT), D. Stamatialis (TNW-AOT), on behalf of the ArtPlac Research Consortium

Introduction

Premature infants with lung and kidney complications experience high mortality. Current therapies, such as mechanical ventilation and artificial organ support, are invasive. To address this, we are developing an Artificial Placenta device (ArtPlac) connected to the umbilical vessels, mimicking the natural placenta's function. ArtPlac integrates oxygenation and dialysis hollow fibers (HF) into one fiber mat, assisting both lung and kidney functions.

Objectives

This study aims to develop the ArtPlac's HF for dialysis, in Outside-in flow mode (OIF). In this configuration, blood flows around the fibers, while dialysis fluid flows inside the lumen of the fibers.

Methods

OIF-HFs are produced using a polymer blend of polyethersulfone, polyvinylpyrrolidone dissolved in N-methylpyrrolidone, via dry-wet <u>spinning and collecting of the HF on the spool.</u> The HFs are soaked in glycerol for 24h, air-dried overnight and characterized using Scanning Electron Microscopy (SEM). The HF are characterised in term of their transport properties (ultrafiltration coefficient, uremic toxins) and mechanical properties (tensile strength, elongation at break…)

Results

The developed HFs present sponge-like pore morphology and are suitable for OIF (selective outer layer in contact with the blood and inner porous layer in contact with the dialysis fluid). The fibers' ultrafiltration coefficient is 6 mL/(m^2·h·mmHg) and tensile strength is comparable to that of commercial HFs.

Conclusion

The OIF HFs show promising filtration and mechanical properties for the ArtPlac device. Future work will address device assembling and toxin removal from human full blood.

Acknowledgements

MONITORING NIPPLE PERFUSION IN NIPPLE-SPARING MASTECTOMIES USING HANDHELD LASER SPECKLE CONTRAST IMAGING

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Abstract

Introduction: Nipple-sparing mastectomy (NSM) with immediate breast reconstruction is increasingly used by surgeons in the treatment of breast cancer. However, necrosis of the nipple-areola complex (NAC) remains a common complication, typically arising from insufficient blood flow within this area. Early intra-operative identification of impaired perfusion may improve outcomes. Handheld laser speckle contrast imaging (LSCI) is a non-invasive optical technique that enables real-time visualisation of perfusion and may therefore support early detection of regions with compromised micro-circulation.

Methods: NAC perfusion was measured in perfusion units (p.u.) using our recently developed handheld LSCI system. Ten women (14 cases) undergoing immediate or delayed reconstruction involving NSM were measured intra-operatively after reconstruction and again one day post-operatively. NAC complications occurring within two months post-operatively were documented. Temporally-averaged perfusion maps were generated using a calibrated conversion table converting speckle contrast to perfusion values. Uneventful and necrotic NAC regions were manually delineated, and mean perfusion per region was calculated for each participant.

Results: Two cases of partial and three cases of complete NAC necrosis occurred within the cohort. Mean perfusion values after reconstruction were 76.2 ± 17.5 p.u. in uneventful cases and 55.0 ± 12.4 p.u. in necrotic NAC cases. One day post-operatively, mean perfusion values were 89.3 ± 30.9 p.u. and 48.9 ± 16.8 p.u., respectively.

Discussion: These results suggest that handheld LSCI holds potential for detecting NAC necrosis in an early stage. Larger studies are needed to further substantiate these findings, combined with further validation against other perfusion-imaging techniques.

PRACTICAL INTER-LABORATORY VARIATIONS IN MOTION CAPTURE MEASUREMENTS AND IMPLICATIONS FOR PERSONALIZED MUSCULOSKELETAL MODELING

Parham Sadeghinia [ET-BE-BDDP], Leendert Schaake [Roessingh Research and Development], Vera Kooiman [Radboudumc], Lise Wilders [Sint Maartenskliniek], Nico Verdonschot [ET-BE-BDDP], Periklis Tzanetis [ET-BE-BDDP]

Introduction

Gait analysis is essential for understanding human movement, yet reproducibility across laboratories remains challenging due to examiner- and lab-specific factors, especially marker placement. This study aimed first to determine how inter-laboratory variations in protocol-execution, including marker placement or execution of an activity, affect knee joint angles and net moments; and second, to assess whether a personalized musculoskeletal model mitigates these effects through its marker optimization process.

Methods

A healthy subject performed walking and step-down activities at three independent gait laboratories following a standardized protocol. All laboratories used the Vicon motion-capture system and the Conventional-Gait-Model 2 marker set. Knee joint kinematics and net moments were calculated using the Conventional Gait model algorithm. A subject-specific musculoskeletal model was then developed in the Anybody Modeling System to perform inverse dynamics analysis and calculate joint angles and net moments. Inter-laboratory differences were quantified using absolute differences in peak knee flexion angle and net moment.

Results

By utilizing the personalized musculoskeletal model, the differences in knee joint angles decreased by maximally 38.4% and 77.9% for walking and step-down trials, respectively; the corresponding decrease in net joint moments was 74.9% and 77.6%.

Discussion

This study showed that inter-laboratory differences in kinematics and kinetics are affected by examiner-dependent marker placement and task execution, which is more variable if the task is more complex, such as in step-down. Using a personalized musculoskeletal model can reduce both kinematic and kinetic differences through marker positioning optimization, thereby supporting a more reliable interpretation of movement analysis outcomes.

A Smart Mattress for Pressure Ulcer Prediction

Gwenn Englebienne (HMI), Thijs Bianchi (I-Tech)

Abstract

Introduction Pressure ulcers and patient falls are persistent safety challenges in healthcare facilities, causing patient harm, increased workload, and rising healthcare costs. Addressing these issues places a significant burden on hospital staff, creating a clear need for technological solutions to support care protocols.

Objective Existing pressure mat studies often lack standardisation regarding positions, setups, and validation methods, limiting reproducibility. This research establishes a reproducible experimental framework to develop and validate a novel, low-cost capacitive pressure mat. The goal was to create a non-intrusive system to monitor patient location, posture, and movement in the bed without compromising comfort.

Methods A soft, flexible prototype was fabricated and tested with 15 participants in a hospital bed, following the Pressure Ulcer Position System guidelines. Machine learning models were trained on pressure data to classify static body positions and movement sequences.

Results The system achieved high accuracy for in-bed localisation of left, right, and centre positions (90.1% ±6.6) and bed exit detection (76.3% ±5.2). For general pressure ulcer risk, the system successfully classified eight distinct posture groups with 72.6% ±10.5 accuracy. However, analysis of 17 specific positions dropped to 37.7% ±8.9, as many positions were similar. Hardware fragility and ground truth ambiguity introduced noise, limiting fine-grained detection.

Conclusion Low-cost capacitive sensing is a viable technology for fall detection and macro-movement tracking in hospitals. However, clinical implementation requires improved hardware robustness and objective ground truth measurements to ensure reliable results and improve fine-grained position detection.

DESIGNING FOR PREVENTIVE HEALTH IN A COMPLEX SOCIETY: 10 STRATEGIES

Naomi van Stralen (ET-DPM-IxD), *Jodi Sturge (ET-DPM-IxD), Geke Ludden (ET-DPM-IxD)*

Introduction

Health decisions cannot be seen as something isolated from our daily lives, but preventive health tools often treat them this way. Complex systems such as our body, society, and ecology all shape and affect how we identify with and act upon our health, our so-called 'health identity'. Insights into experiences, personal values and environmental contexts can be a way to make health interventions and technologies more inclusive.

Objective

How might understanding health as a personal experience, positioned in a larger system, empower people to meaningfully reflect upon and engage with their health to formulate and sustain lifestyle changes?

Framework

To explore health identity, we developed a framework that integrates three concepts:

1. *Experienced health* – How people perceive their own health
2. *Personal values* – Deeper motivations that guide people's decisions
3. *Socio-ecological system* – Real-world contexts in which people operate

Methods

Based on the framework, we performed a qualitative research study with 13 participants from diverse backgrounds. The study included concepts of positive health, value-based design, and systemic design. Guided by participatory activities and semi-structured interviews, participants formulated personal health objectives and self-experimented for three months to integrate these objectives into their day-to-day life.

Findings

Based on the collected data we developed ten design strategies that can support positive lifestyle changes and long-term engagement with preventive health tools.

Conclusion

This knowledge contributes towards the design of personal health tools, policy, and technology that better accounts for the complexity and ever-changing contexts of daily life.

A MULTI-SENSORY DESIGN APPROACH TO HOSPITAL AT HOME

First and last name of presenting author (Affiliation between brackets, written as abbreviation as used on People pages, e.g. TNW-BIS-M3i or BMS-TPS-HTSR) underlined, First and last name (Affiliation) of all co-authors

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Abstract

- Max 256/250 words for a broad TechMed audience, not experts in your field

Introduction: Healthcare systems are undergoing transformation to address the growing demand for services driven by an ageing population, complex chronic disease, workforce shortages, and high costs. Hospital at Home (H@H) is an emerging model that delivers hospital-level care to patients in their own homes rather than in traditional hospital wards. Hospital at home has expanded across multiple care pathways and healthcare systems, supported by digital health technologies, remote monitoring tools and policy incentives to reduce hospital congestion and costs and increase person-centred care.

Objective: The design of most H@H monitoring technologies is driven by functional performance and does not always account for the dynamic home environment or the everyday lives of patients. Therefore, there are opportunities to enhance H@H monitoring by adopting a multi-sensory design approach aimed at improving patient and staff experiences.

Methods: Multi-sensory design acknowledges that people react to health technology at different levels of experience, subtle and obvious, consciously and unconsciously. The combined sensory features of health technology will influence adoption, and overtime eventual health outcomes .

Results: From the UT master course Multi-sensory Design four student projects were selected that responded to design challenges provided by two hospitals – a H@H monitoring device kit and a patient monitoring app. The design concepts were redesigned for the home environment and demonstrate ways to enhance H@H monitoring through the design of devices that cater to the senses.

Conclusion: We highlight the UT 'people first' profile in this emerging research field and show how multi-sensory design approaches can enhance the H@H experience in the home environment.

DIFFERENCES IN PHYSIOLOGIC ACTIVITY DISTRIBUTION BETWEEN MALE AND FEMALE WITH [18F]FDOPA PET/CT IMAGING

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Abstract

This study aimed to investigate sex- and age-related differences in the physiological distribution of [^{18}F]FDOPA uptake in long axial field-of-view (LAFOV) PET images across a range of organs and tissues. A retrospective quantitative data analysis study of 106 anonymised PET/CT images acquired from vertex to mid-thigh with minimal abnormalities, divided in two gender groups and two age groups was used for this study. The mean and maximum standardized uptake value normalized for lean body mass (SUL$_{mean}$ and SUL$_{max}$), target background ratio (TBR), and coefficient of variance (CoV) were used to quantify tracer uptake.

Sex- and age-related differences in uptake were organ- and metric-specific. Most organs showed comparable uptake between males and females. However, males exhibited higher absolute uptake in metabolically active organs and females showed greater intra-organ heterogeneity. Ageing was generally associated with increased tracer uptake and variability, especially in women, with the hip showing higher uptake in younger individuals. Statistically significant differences were most prominent in women and varied by organ and metric.

In conclusion, both sex and age significantly influence [^{18}F]FDOPA PET tracer uptake and variability in an organ- and metric-specific manner. Incorporating sex- and age-adjusted reference values may improve the accuracy and personalization of PET imaging in clinical and research settings.

USAGE OF SULFONATED POLYMER AS AN ADDITIVE FOR FABRICATION OF LONG TERM FILTRATION HOLLOW FIBER MEMBRANES FOR DILAYSIS

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Introduction
Hollow fiber membranes are responsible for uremic toxin removal during the dialysis. They are usually made from hydrophobic polyethersulfone and hydrophilic additive polyvinylpyrrolidone (PVP) used for pore formation and increasing hemocompatibility. It has been shown that PVP can be eluted from membranes during the sterilisation process or treatment. That can lead to decrease in hydrophilicity and by that hemocompatibility and result in increased protein fouling impeding membrane functionality. This is one of the limiting factors for achieving long term blood filtration (LTF), for improving toxin removal and patients' quality of life.

Objective
Fabrication hollow fiber membranes for dialysis patients with the usage of alternative hydrophilic polymer additive, a sulfonated polymer.

Methods
Membranes are fabricated using liquid induced phase separation. Their morphology, ultrafiltration coefficient (K_{UF}) and resistance to protein fouling before and after 24h filtration with water were investigated. Additionally, uremic toxin removal and fibers biocompatibility were tested.

Results
The developed fibers were either low flux (K_{UF} of 16 ± 3 ml/(m^2*h*mmHg)) or high flux (K_{UF} of 45 ± 6 ml/(m^2*h*mmHg)). Low flux fibers show good resistance to fouling, while high flux fibers are susceptible to fouling. Both have good protein retention and stay stable after 24h filtration without change in anti-fouling properties. Degree of uremic toxin removal is similar for both fiber types.

Conclusions
Usage of alternative polymers allowed for fabrication of fibers that do not show performance difference before and after LTF with good uremic toxin removal. Low flux fibers show better anti-fouling properties than high flux membranes.

NUCLEIC ACID BIOINSPIRED HYDROGELS FOR ADVANCING MICRO-ENGINEERED HEART TISSUE MODELS

Neha Thakur (TNW-DBE), Minye Jin (TNW-DBE), Corné van Dam (TNW-AST), Robert Passier (TNW-DBE) and Andries van der Meer (TNW-AST), Julieta I Paez (TNW-DBE).

Abstract

Cardiovascular disease (CVD) is the primary cause of deaths among cardiac patients, demanding significant increase in interventions in this field. One line of action involves the engineering of cardiac tissue models to study CVD and to test novel therapeutics. One such advanced platform is human Engineered Heart Tissue (EHT), which has emerged as an important enabling tool for cardiac drug development, and therapeutic applications. In EHTs, cardiac cells are embedded in hydrogels and electrically stimulated to prompt tissue formation, but commonly used hydrogels are not conductive, which limits model applicability. In contrast, inherently conductive hydrogels are expected to facilitate the advancement of EHTs, by enabling milder electrical stimulation.

With this motivation, here we present a bio-inspired, ion-conductive supramolecular hydrogel to provide a regenerative microenvironment for cardiac tissue formation. In our system, biogenic molecules induce the formation of ion-conductive hydrogels which provide a favorable environment for cardiac cells. We show how the unique conductive and hierarchical 3D fibrous network, along with its cytocompatibility, pave the way for cardiac cell culture and contribute to the development of 3D cardiac tissue models of increasing physiological relevance. These hydrogels were successfully formulated as matrices for co-culture of cardiac cells, showing fast gelation time, fibrillar microstructure, and tunable mechanics, within such EHT platforms. We envisioned that the bio-inspired hydrogels proposed here provide a valuable alternative to existing biomaterials, and are promising for engineering tissue cardiac models.

Bumblebees, Dance Class Rides, and the Strength of Awareness: Enhancing Students' Awareness of Meaningful Moments through a Positive Psychology App

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Ernst Bohlmeijer (BMS-HIB-PHT)

Abstract

Introduction. Many students struggle with mental health challenges, yet few seek support due to stigma, limited access to care, or time constraints. Digital positive psychology interventions (PPIs) offer a low-barrier, student-friendly approach to improving well-being by focusing on positive aspects of life rather than difficulties. This qualitative study explored how students experienced a digital PPI and the impact it had on their daily lives.

Methods. Fourteen students from psychology and communication science participated in an 18-day self-guided intervention using the evidence-based multicomponent PPI app Training in Positivity (TiP). The app included mindfulness-based audio exercises and six PPIs: savouring (Three Good Things), setting goals, strengths, self-compassion, setbacks as lessons, and spreading kindness (Acts of Kindness). Students engaged with the app for 10-15 minutes daily. Post-intervention, semi-structured interviews were conducted. Thematic analysis was conducted by two independent researchers.

Findings. Students reported increased awareness of positive and meaningful moments, and a strengthen sense of connection, particularly with loved ones. Many described a shift in perspective and an increased ability to pause, reflect and manage stress. Participants also valued simple, practical tools introduced by the intervention. One student summarised the experience as "positivity, kindness, and connection".

Discussion. These findings suggest that even a brief, self-guided intervention can offer meaningful support students well-being and promote everyday awareness of positive experiences. These benefits highlight the potential of PPIs in higher education settings. However, future research should include randomized controlled trial to evaluate the app's effectiveness and broader applicability in diverse student samples.

Cross-Border Ambulance Positioning

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Dr. Amin Asadi [BMS-HBE-IEMS]
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Introduction
Emergency Medical Services (EMS) face growing pressure. The number of emergency calls is rising, while the resources, particularly EMS staff and ambulances, remain limited. This challenge is especially evident in border regions. In these areas, ambulances from a neighbouring country can sometimes reach patients faster, but cross-border collaboration remains rare and largely manual. Differences in organisation, rules, and information systems make collaboration difficult.

Objective
This project aims to improve ambulance availability and response times in the German–Dutch border region. The goal is to explore how ambulances can be positioned and relocated across the border in a safe, fair, and efficient manner, without adding new ambulances.

Methods
We study how ambulances are currently stationed, dispatched, and relocated in Germany and in the Netherlands. We then develop a data-driven decision-making framework that respects national rules, staff working conditions, and response standards. The approach integrates operational data, time-dependent travel times, and demand patterns to help practitioners determine when and where cross-border collaboration is beneficial.

Results
This project is ongoing. At this stage, no final results are available. The planned analyses will assess the impact of cross-border ambulance positioning on response times, coverage levels, and workload distribution across different demand scenarios.

Conclusion
Because the project is still in progress, final conclusions cannot yet be drawn. The expected contribution is to provide evidence-based insights and practical guidance on organising cross-border ambulance collaboration to support timely, safe, and equitable emergency care in border regions.

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LEG ALIGNMENT NORMAL VALUES OF A 2D FRAMEWORK MIGHT NOT BE VALID FOR A CONSENSUS-BASED 3D FRAMEWORK

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Abstract

Introduction An international Delphi consensus recently defined fundamental principles for a 3D leg alignment analysis framework, but its clinical implications and comparability with established 2D alignment parameters remain unclear. This study aimed to quantify agreement and systematic differences between knee-related leg alignment parameters measured using the conventional 2D framework and a consensus-based 3D framework.

Methods Patients were retrospectively included if they underwent both 2D radiographic and 3D CT-based alignment analysis between 2022 and 2025. Coronal, sagittal, and axial alignment parameters relevant for knee osteotomy planning were measured on the affected limb using a Paley-based 2D workflow and two distinct 3D workflows adhering to the Delphi consensus framework. Systematic differences between methods were assessed.

Results 61 patients were included, of whom 41 had complete sagittal plane radiological data. Significant differences between 2D and 3D measurements were found for 10 of 14 alignment parameters (71%). Six parameters demonstrated systematic differences of at least 1° (MPTA, mPPTA, mMPPTA, aPPTA, aMPPTA, and TTA). One parameter (FVA) differed by more than 0.5° between the two 3D workflows.

Discussion Although many knee-related alignment parameters differed statistically between 2D and 3D frameworks, clinically relevant differences were mainly observed for tibial alignment parameters. Existing 2D-based normal values may therefore not be directly applicable to 3D clinical decision-making, emphasizing the need for 3D-specific reference standards.

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EVALUATION OF AN ELECTROMAGNETIC APPROACH FOR QUANTIFYING IMPLANT LOADS IN VIVO

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Introduction
Adolescent Idiopathic Scoliosis is a three dimensional spinal deformity which develops during growth. A non-fusion correction implant was developed to correct scoliosis while allowing spinal growth. In vitro mechanical behaviour of the implant was studied previously, but the in-vivo mechanical behavior is marginally explored. As studying implant loads in vivo presents technical challenges, due to minimally invasive requirements and limited availability of implantable sensors, this in vitro study evaluated the use of wired position sensors to measure implant kinematics and translate this via known implant stiffness into loads.

Method
The NDI Aurora wired electromagnetic (EM) system was used to measure implant kinematics. Three six degrees of freedom (6DOF) EM sensors were attached to the implant, mounted in a custom-made spine set-up equipped with 6DOF load cells. Baseline calibration was established via palpation of distinct landmarks with a 6DOF EM probe. Subsequently, the set-up was positioned in multiple configurations while implant kinematics were tracked. Implant kinematics were transformed to implant loads using known spring characteristics and these were validated against 6DOF load measurements.

Results
EM-derived distraction forces ranged from 24.55 to 28.38 N, and torques ranged from 0.14 to 0.25 Nm. Maximum difference between the EM-derived and loadcell derived distraction force was 1.31 N and torque was 0.14 Nm.

Discussion
The EM-derived implant loads show strong correspondence with load cell measurements. The difference can be partly explained by the limited resolution of the load cells. The small differences indicate that the EM-based approach is feasible for measuring in vivo implant loads.

THE PERSONALIZED CANCER TREATMENT AND CARE (PARTNR) PROJECT: OPTIMIZING INTERVENTION RECOMMENDATIONS FOR BREAST CANCER-RELATED FATIGUE

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Abstract

Introduction – Cancer-related fatigue (CRF) is the most frequently reported symptom after breast cancer. Although various interventions exist, their effectiveness differs between individuals. PARTNR aims to integrate comprehensive data on daily functioning to deliver *personalized recommendations for CRF interventions* based on patient's characteristics, needs, and preferences.

Methods – Machine learning models were developed to predict CRF (12,813 patients) based on patient's characteristics. To explore patient needs, four focus groups with 27 patients and interviews with 14 healthcare professionals were conducted, resulting in a holistic patient profile using reflexive thematic analysis. This profile was conceptualized into the Holistic Assessment of CRF (HA-CRF) questionnaire to monitor CRF and further studied for its face and content validity with 10 patients and HCPs. Feasibility and usability were assessed in 19 patients during a four-week monitoring period and group interviews. A scoping review identified attributes of CRF-interventions, which were informed a preference elicitation model. Individual patient data from 22 exercise and 14 psychosocial randomized controlled trials (n=3995) were used to estimate expected intervention benefit.

Results – Based on the available patient characteristics, fatigued and non-fatigued patients could not be accurately distinguished. The HA-CRF, consisting of experience of CRF and perpetuating factors, demonstrated good face and excellent content validity. Completion rates exceeded 75%, though adherence was 21%. Acceptability varied, and patients provided actionable feedback. Pre-intervention fatigue was the strongest predictor of post-intervention fatigue for both intervention types.

Conclusions – Identified patient needs, preferences, and expected benefit will inform the development of explainable, personalized recommendations for CRF-interventions.