

HEALTHY LONGEVITY GLOBAL COMPETITION

2025 Catalyst Awardees

Sponsor: Chinese Academy of Medical Sciences

A Multi-Disease AI Agent for Ultra-Widefield Imaging-Based Screening and Clinical Decision Support

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PROJECT DESCRIPTION

To address China's severe shortage of fundus specialists and the disparity in rural medical resources, this project develops an intelligent screening system integrating ultra-widefield (UWF) fundus imaging and a multi-disease deep learning model. By utilizing a 200° UWF view (covering 82% of the retina), the system significantly reduces peripheral lesion miss rates. The AI model, trained on 60,000 images from 26 hospitals, screens for 25 fundus conditions with an average AUC of 0.915. A streamlined rural workflow enables non-mydratic imaging in one minute, with 5G facilitating cloud-based real-time analysis and AI-driven patient communication. This approach cuts screening costs to 1/5–1/8 of traditional methods, reduces late-stage blindness by 18–22%, and lowers annual per-patient treatment costs by ¥8,500–¥12,000. As the world's first UWF-AI system covering 25 diseases, it provides a scalable solution for population-wide fundus disease prevention and supports the Healthy China initiative.

A Novel Electrospun Polyurethane Membrane for Posterior Scleral Contraction Surgery in High Myopia: Development and Mechanism

Principal Investigator	Chan Wu, MD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Rongping Dai, MD; Zhikun Yang, MD; Huan Chen, MD; Mingyue Luo, MD; Meng Wang, MD

PROJECT DESCRIPTION

High myopia is a major public issue in global visual health, and posterior scleral dilation is the main pathological mechanism of high myopia fundus lesions. Existing posterior scleral contraction or reinforcement materials have limitations in long-term safety and efficacy stability. Therefore, it is urgent to develop new materials for posterior scleral retraction surgery and explore related mechanisms of action. This study is based on electrospun polyurethane membrane, and significantly improves its mechanical properties (such as tensile strength and elastic modulus) and biocompatibility by optimizing the process parameters and

component ratios of the membrane material. At the same time, the safety and effectiveness of the membrane material were verified through animal experiments, and the effects of the membrane material on the proliferation, migration, and anti-inflammatory properties of scleral fibroblasts were investigated. The biological mechanism of the material promoting extracellular matrix (ECM) remodeling in sclera was systematically analyzed. This study

constructed a complete system of "material design performance optimization biological regulation mechanism analysis", confirming the advantages of electrospun polyurethane membrane in mechanical matching, biocompatibility, and ECM regulation, and opening up a new path for the treatment of complications of high myopia.

AI Model-Based Wearable and Implantable Atrial Fibrillation Monitoring Devices for Elderly AF Cohort Management Study

Principal Investigator	Zhijun Sun, MD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Tong Zou, MD; Honggang Qi, PhD

PROJECT DESCRIPTION

China's rapidly aging population is projected to exceed 300 million during the 14th Five-Year Plan period, with atrial fibrillation (AF) prevalence surpassing 10% in individuals aged 75 years and above. AF reduces life expectancy by 1.8–2.3 years and increases stroke risk. Although wearable photoplethysmography (PPG) devices provide wrist-based continuous monitoring and low cost, they still lack medical-grade validation standards. This project aims to conduct a PPG diagnostic concordance study based on the Insertable Cardiac Monitor (ICM) for AF diagnosis, and to construct an intelligent management system for elderly AF cohorts using wearable watches with a comprehensive in-patient and out-patient management dashboard. The research objectives are to: (1) develop medical-grade PPG AF monitoring technology with accuracy exceeding 95%; (2) establish a PPG-ICM diagnostic concordance assessment system; (3) develop an interactive AF management app; and (4) establish a pilot intelligent management system for elderly AF cohorts. The technical approach includes utilizing our 400 ICM implantation cohort to establish a PPG-ICM gold standard comparison validation system; conducting diagnostic concordance comparative studies based on 72 AF patients and 72 non-AF controls; developing a smart app integrating AF monitoring, burden assessment, medication management, and stroke screening; and performing prospective validation in 100 newly implanted ICM patients. Expected outcomes include achieving medical-grade PPG AF monitoring technology, establishing the ICM diagnostic concordance validation system, developing 3–5 invention patents, completing the AF management app, and publishing 2–3 JCR Q1 papers, while reducing PPG technology costs and providing convenient, precise monitoring solutions for elderly AF patients.

Application of a Novel Hybrid Surgery Strategy in Elderly Patients with Multiple Primary Lung Cancers: A Prospective Validation Study

Principal Investigator	Qi Xue, MD, PhD
PI Primary Affiliation	"National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College"
Co-Investigator(s)	None

PROJECT DESCRIPTION

According to the latest cancer data of WHO, lung cancer (LC) remains the leading cause of incidence and mortality both globally and in China. The diagnosis and treatment of multiple primary lung cancer (MPLC) continue to pose significant challenges for clinicians. As the global population ages, an increasing number of elderly patients are being diagnosed with MPLC, drawing greater attention to the health and longevity of this demographic. Although video-assisted thoracoscopic surgery (VATS) is the preferred treatment method for MPLC, there is no clear consensus on the optimal treatment strategy. Elderly MPLC patients often have multiple comorbidities and reduced physiological function, making surgery more risky and postoperative recovery more

difficult. Achieving tumor eradication while minimizing trauma and maximizing lung function preservation is a pressing clinical challenge. In recent years, ablation technology has matured, offering a promising local treatment option for MPLC. The combination of VATS and ablation therapy leverages the advantages of surgery in achieving radical resection, lymph node dissection, and precise pathological staging, while also taking advantage of the minimal trauma, repeatability, and limited lung function loss associated with ablation therapy.

Our research team, as a leading national center of thoracic surgery, performed this hybrid surgery in China and published the largest retrospective case study globally to date. Our preliminary studies have demonstrated that the hybrid surgery is highly safe and feasible in the general MPLC population and significantly improves postoperative quality of life. However, high-level evidence and standardized protocols for elderly MPLC patients remain lacking, and the broader applicability of this innovative strategy requires further investigation. Building on our previous research, our team plans to conduct a multicenter real-world study based on a prospective clinical cohort. This study will compare VATS combined with thermal ablation versus VATS alone in elderly MPLC patients, focusing on both unilateral and bilateral MPLC. We will evaluate and compare the two treatment modalities in terms of safety, efficacy, lung function loss, postoperative complications, postoperative quality of life, long-term survival, and health economics. The goal is to develop and disseminate best practices for the treatment of elderly MPLC patients, providing a basis for establishing the optimal individualized treatment strategies, improving the health service system for the elderly, and offering China's experience and treatment solutions to address global aging.

Cohort Study Developing a Risk Prediction Model for Lower-Limb Ischemia in Older Adults Based on a Multidimensional Data Platform

Principal Investigator	Zuoguan Chen,MD
PI Primary Affiliation	Beijing Hospital, National Center of Gerontology, Institute of Geriatric Medicine, Chinese Academy of Medical Sciences
Co-Investigator(s)	Chengran Lu,MD;Peng Li,MD;Yuqing Miao Phd;Xihao Zhang;Wenxin Zhao;Yaming Guo;Bowen Zhang

PROJECT DESCRIPTION

Ischemic lower-limb disease has a high prevalence and high severity among the elderly, and its heterogeneity makes it a major threat to healthy longevity in this population. The current diagnostic and treatment system faces three major problems: difficulty in early diagnosis, suboptimal treatment outcomes, and difficulty in prognostic prediction. The main reason is the neglect of imaging features of the muscle target organ and the multi-omics changes associated with ischemia and hypoxia. Based on prior work, the applicant originally proposed the “vascular–muscle–microenvironment imbalance” concept (awarded an NSFC general project in 2024) and, leveraging the country’s first multimodal database (VIP platform, clinical–imaging–omics data from 2,000 patients), has overcome the limitations of traditional single-dimensional assessments. First, by integrating “degree of vascular stenosis — plaque lesion characteristics — muscle target-organ injury,” a CTA imaging metric evaluation standard was constructed, emphasizing the importance of assessing the muscle target organ. Second, using plasma proteomics and metabolomics, a comprehensive assessment system for the lower-limb ischemic microenvironment was developed, clarifying the importance of evaluating systemic frailty, inflammation, and glucose–lipid metabolic microenvironment homeostasis. Finally, AI was used to build an integrated multimodal predictive model for disease risk stratification and prognostic assessment. Machine learning algorithms will provide full-cycle decision support for preoperative clinical risk stratification and postoperative rehabilitation warning, offering reliable tools for clinical decision-making and improving the diagnosis and treatment of lower-limb ischemic disease in our country.

Constructing a diagnostic model for differentiating benign and malignant pulmonary nodules based on multi-omics diagnosis technology

Principal Investigator	Xuzhen Qin, MD.
PI Primary Affiliation	Peking Union Medical College Hospital, Chinese Academy of Medical Sciences
Co-Investigator(s)	Jing Zhao, MD.; Ping Wang, MD.; Yuan Huang, MS.; Di Wang, MD.; Yanlian Yang, PhD.; Zhili Li, PhD.; Yalong Jiang, PhD.; Jiayu Xiao, MS.

PROJECT DESCRIPTION

Lung cancer is the leading cause of cancer-related deaths worldwide. The difficulty in its early diagnosis results in a 5-year survival rate of less than 20% for patients. This project addresses the clinical challenge of differentiating benign and malignant pulmonary nodules, innovatively proposing the "multi-omics-AI fusion diagnosis" strategy: by integrating serum proteomics, exosome protein detection, quantitative glycosylation modification sites, and related clinical and imaging information, it breaks through the limitations of traditional single biomarker or imaging diagnosis. Based on the 500-patient prospective cohort established previously (IA stage lung adenocarcinoma confirmed by pathology standards vs. inflammatory/glandular benign nodules, nodules without progression, and no nodules), a standardized process is used to separate patients' serum, combined with high-throughput multi-omics detection and feature engineering to screen key variables. Multiple algorithms are used for machine learning, analyzing the interaction network of biomarkers, constructing a risk probability model, using interpretable algorithms to provide human-understandable visual explanations for the prediction results of each patient, and verifying in an independent cohort. Expected outcomes: the sensitivity of IA stage lung cancer detection $\geq 85\%$ (AUC > 0.93), the false positive rate reduced by 30%; 1~2 SCI papers and 2 national invention patents will be produced; an auxiliary diagnosis system will be developed, promoting the transformation of lung cancer screening from "empirical follow-up" to "precision intervention", significantly improving the early diagnosis rate and improving the survival prognosis of patients.

Coronary vascular ageing and intervention

Principal Investigator	Miao Wang, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences Fuwai Hospital, National Center for Cardiovascular Diseases
Co-Investigator(s)	Hong Chen, PhD Jinqing Yuan, MD Qing Wan, PhD Jianfeng Yang, MS Haojie Rao, BS Xuejian Yang, PhD candidate Xiao Yu, PhD candidate Tengyue Luo, PhD candidate

PROJECT DESCRIPTION

Vascular aging is central to healthy lifespan. "A man is as old as his arteries". The close relationship between vascular health and longevity is well documented in Chinese medicine and Western medicine for centuries and has been validated by recent multi-omics studies. It is also evidenced by the fact that coronary artery disease (CAD), a disease mostly precipitated by aging, is the leading cause of death worldwide. Inflammation drives CAD development and is increasingly appreciated as a hallmark of vascular aging, however, inflammatory targets that regulate both vascular ageing and CAD remain unclear. Harnessing an integrated approach and translational animal models of vascular aging and coronary atherosclerosis, combined with human coronary vascular assessment, we recently identified key targets of vascular inflammation (Circ Res, 2022 & 2025; Nat Commun, 2024; Cardiovasc Res 2025; etc).

To discover novel interventions of vascular aging-related diseases, this project will (1) identify key targets of coronary vascular aging and atherosclerosis; (2) clarify mechanisms of action of inflammatory targets; (3) develop novel drugs to prevent age-related cardiovascular diseases, CAD and heart failure. This project explores healthy aging by advancing the "vascular health" concept. It is expected to bring 1–2 patented investigational new drugs to phase I/II clinical trial stage.

Professor Miao Wang, the Principal Investigator, leads a translational discovery group at the State Key Laboratory of Cardiovascular Diseases, Fuwai Hospital (also known as the National Center for Cardiovascular Diseases), Chinese Academy of Medical Sciences. He has both academic (University of Pennsylvania) and industrial (Pfizer) work experience.

Design, Validation and Preliminary Clinical Study of a Novel Total Knee Prosthesis Incorporating Mechanically Enhanced Scaffolding Technology

Principal Investigator	Jia Zhang, MD
PI Primary Affiliation	Peking Union Medical College Hospital, Chinese Academy of Medical Sciences Peking Union Medical College
Co-Investigator(s)	Hengyan Zhang, MD; Xuemeng Mu, MD

PROJECT DESCRIPTION

Total knee arthroplasty (TKA) effectively treats end-stage osteoarthritis, but periprosthetic fractures remain a serious complication, especially in elderly osteoporotic patients. This project proposes a novel concept of "mechanical reinforcement for prevention" by designing a lateral support component for the femoral prosthesis.

Using high-precision CT scans, patient-specific finite element models will be established to identify stress concentration zones in the distal femur post-TKA. Based on this analysis, a cobalt-chromium alloy support component will be innovatively designed, optimizing its geometry and placement to reinforce the lateral distal femur.

The component's efficacy will be validated through finite element simulation, biomechanical testing, and animal studies. This approach is expected to fundamentally improve stress distribution, significantly reduce periprosthetic fracture incidence, and improve patient outcomes, offering substantial clinical and socioeconomic benefits.

Development and Application of a Novel Rotavirus Spike Protein–Glycan Recognition-Based Technology for Early Diagnosis of Cancer and Aging-Related Diseases

Principal Investigator	Yang Liu, PhD
PI Primary Affiliation	Institute of Radiation Medicine, Chinese Academy of Medical Sciences and Peking Union Medical College
Co-Investigator(s)	Xiaotong Zhao, PhD; Qin Wang, PhD

PROJECT DESCRIPTION

As the body ages, glycosylation modifications on cell surfaces undergo changes. These alterations in glycosylation are closely associated with the onset and progression of various diseases and often precede changes at the protein level. Therefore, glycosylation modifications can serve as sensitive markers for the early diagnosis of numerous degenerative diseases and tumors. In our previous research, we found that the spike protein VP8* of rotavirus can specifically recognize and bind to oligosaccharides as receptors. Moreover, the capsid spike proteins of different genotypic sequences can specifically recognize different types of glycan antigens. Based on this, in the current project, we aim to utilize the specific binding characteristic of rotavirus

capsid spike protein to oligosaccharides on tissue cell surfaces. By using P-particles formed by the highly self-assembling P domain of norovirus, we will construct and express in vitro protein systems that can specifically recognize various glycan antigens. Through random mutagenesis of the VP8* protein sequence, we will screen and develop highly sensitive, highly specific, and easy-to-operate in vitro glycosylation modification detection methods capable of recognizing various glycan antigens related to tumors and age-related degenerative diseases on the surface of tissue cells. This research will provide a foundation for understanding the pathological processes of aging-related diseases and for detecting disease-associated glycosylation modifications. It will also further promote basic research and clinical application of glycosylation detection in the diagnosis of degenerative diseases, thereby improving the accuracy and efficiency of early disease diagnosis.

Development and Clinical Application Research of a Multi-modal Imaging AI-guided Integrated Robotic System for Prostate Targeted Biopsy and Focal Therapy

Principal Investigator	Miao Wang, MD
PI Primary Affiliation	Beijing Hospital
Co-Investigator(s)	Xin Chen, MD Wei Zhang, MD Chunmei Li, MD Wenrui Xu, MD Shengjie Liu, MD Jinxin Yang, MD

PROJECT DESCRIPTION

This project aims to address the clinical issues during focal therapy for prostate cancer by integrating biopsy and pathological information under a "diagnosis-treatment integration" strategy. The system will be optimized according to the requirements of surgical navigation for focal therapy, forming a unified robotic system for "Multimodal Imaging and AI-Assisted Targeted Prostate Biopsy and Focal Therapy." This approach seeks to enhance the precision and efficacy of IRE, reduce technical complexity, enable promotion to primary healthcare centers, and ultimately extend the "healthy lifespan" of elderly PCa patients while improving the overall quality of PCa treatment in China.

Development of Bedside Three-Dimensional Electrical Impedance Tomography for Lung Ventilation and Perfusion Imaging and Its Application in Acute Respiratory Failure

Principal Investigator	Huaiwu He, MD
PI Primary Affiliation	Peking Union Medical College Hospital, Chinese Academy of Medical Sciences
Co-Investigator(s)	Siyi Yuan, MD; Yi Chi, MD; Zhanqi Zhao, PhD; Maokun Li, PhD

PROJECT DESCRIPTION

Acute respiratory failure (ARF) caused by conditions such as pneumonia or pulmonary embolism is a major cause of mortality in critically ill patients, especially the elderly, and poses a significant threat to healthy longevity. Monitoring pulmonary ventilation and perfusion is central to ARF management; however, conventional tools such as chest X-ray, CT, CTPA, and nuclear imaging carry transport risks, radiation exposure, and procedural delays, making them unsuitable for real-time bedside assessment. Thus, a noninvasive, bedside, and dynamic monitoring technique is urgently needed to support precision treatment of ARF. This project aims to develop a high-precision bedside three-dimensional electrical impedance tomography (3D-EIT) technology for simultaneous imaging of lung ventilation and perfusion. By integrating individualized 4D-CT-based dynamic calibration with AI-driven algorithms, the system will enable real-time and accurate whole-lung monitoring, while clinical studies will establish evidence-based strategies for its application in respiratory failure management. The technological pathway includes addressing the nonlinear nature of 3D-EIT using physics-informed neural networks (PINN) for forward physical modeling and embedding physical constraints into network optimization;

incorporating patient-specific 3D-CT lung contours and 4D-CT ventilation dynamics as structural priors to mitigate the ill-posedness of 3D-EIT reconstruction; leveraging large-scale GPU parallel computing to enable real-time 3D image reconstruction; and conducting clinical research to develop practical clinical implementation strategies for 3D-EIT.

Development of the original drug IMB-C52 for treating glucose and lipid metabolism disorders based on multi-target synergistic mechanisms

Principal Investigator	Hu Li, PhD
PI Primary Affiliation	Institute of Medicinal Biotechnology, Chinese Academy of Medical Sciences and Peking Union Medical College
Co-Investigator(s)	Danqing Song, PhD; Zonggen Peng, PhD; Yonghua Liu, PhD; Jingyang Zhu, PhD; Ning Li, MS;

PROJECT DESCRIPTION

Diabetes, fatty liver disease, and other chronic conditions associated with glucose and lipid metabolism exhibit complex etiologies and frequently coexist with multiple comorbidities. Current drug development faces significant challenges in reversing core pathophysiological processes. In response, we have ingeniously conjugated berberine, a natural agent known for its glucose- and lipid-lowering properties, with bicyclol, a hepatoprotective and anti-inflammatory compound, to formulate a novel oral small molecule. This innovative drug exerts synergistic actions across multiple targets. In an early mouse model of metabolic dysfunction-associated steatotic liver disease (MASH), it exhibited superior efficacy compared to both the physical combination of its components and the marketed drug Resmetirom, particularly in its ability to lower glucose and lipid levels, protect liver function, and improve hepatic pathology, all while maintaining a favorable safety profile. The current project aims to further assess the therapeutic effects of our novel compound in animal models of diabetes, MASH, and related multimorbidity conditions. Additionally, we intend to optimize large-scale synthesis processes, characterize its pharmacokinetic and safety profiles, and elucidate its unique multi-target and sequential synergistic mechanisms, particularly those involving the gut-liver axis and metabolic/inflammatory pathways, thereby facilitating subsequent translation into clinical research.

Engineered Stem Cell Vesicles with Immune Checkpoints for Arthritis Microenvironment Remodeling and Immunomodulatory Therapy

Principal Investigator	Wen Li, PhD
PI Primary Affiliation	Institute of Biomedical Engineering, Chinese Academy of Medical Sciences and Peking Union Medical College
Co-Investigator(s)	Tianjiao Wang, PhD; Xueping Li, PhD; Lu Zhang, PhD; Baohui Yuan, PhD; Yi Li, MS; Xuya Yu, MS

PROJECT DESCRIPTION

Rheumatoid arthritis (RA) is a chronic, systemic autoimmune disorder characterized by aberrant activation of the immune system. Current therapeutic regimens can partially alleviate symptoms and slow joint damage but rarely achieve complete remission or effectively restore immune homeostasis, and long-term administration is often limited by significant adverse effects. In this project, we propose the development of a novel biomimetic engineered stem cell nanovesicle platform that integrates dual immunoregulatory and microenvironment-remodeling functions. Specifically, mesenchymal stem cell (MSC)-derived nanovesicles will be genetically engineered to overexpress programmed death-ligand 1 (PD-L1), leveraging both their inherent immunomodulatory activity and immune checkpoint signaling to selectively suppress overactivated pathogenic T cells, modulate aberrant immune responses, prevent immune-mediated tissue damage, and restore immune

tolerance. In parallel, catalytically active nanoclusters with multi-enzyme mimetic functions will be anchored onto the vesicle surface via stimulus-responsive linkers to selectively scavenge excessive reactive oxygen species (ROS) within inflamed tissues, thereby disrupting the pathological immune–oxidative stress feedback loop at its source. Animal studies demonstrate that this platform markedly attenuates joint inflammation, preserves cartilage and tissue architecture, and restores the Th17/Treg balance, ultimately maintaining immune homeostasis and tissue function. By integrating genetic engineering and chemical engineering approaches, this work establishes a novel stem cell nanovesicle system with synergistic immune reprogramming and microenvironment remodeling capabilities. This strategy offers a promising avenue for precise intervention in autoimmune diseases that severely threaten human health, holding substantial scientific significance and societal value in extending healthy lifespan and reducing disability rates.

High-Sensitivity and High-Specificity Rapid Detection of Bacterial Infections

Principal Investigator	Hai-Yu Hu, PhD
PI Primary Affiliation	Institute of Materia Medica, Chinese Academy of Medical Sciences and Peking Union Medical College
Co-Investigator(s)	Leilei Zhang, PhD; Qian Liu, PhD

PROJECT DESCRIPTION

Bacterial infections remain a major global health threat, and the rise of antimicrobial resistance highlights the need for rapid, accurate, and low-cost pathogen diagnostics. We previously developed an NTR-activated fluorescent probe that is non-fluorescent in its native state but rapidly turns on in the presence of bacterial NTR and NADH, enabling selective real-time imaging of live bacteria. The probe shows minimal interference from hypoxic tissues, reaches reaction equilibrium within minutes, and enables ultra-rapid detection within 30 min. It has been successfully applied for rapid identification of ESKAPE pathogens. Building on these results, this project aims to optimize probe synthesis for scalable production, establish a sensitive and specific detection workflow and prototype kit, validate its performance across ESKAPE species, and evaluate clinical feasibility in sputum, urine, and blood samples. The overall goal is to deliver a clinically applicable diagnostic workflow that enables rapid pathogen identification and antimicrobial resistance screening, thereby supporting translational development and generating high-impact outcomes.

Home-based Multimodal Rehabilitation Strategy for Degenerative Shoulder and Knee Disorders in Older Adults Driven by Sensors, Computer Vision & Intelligent Agents

Principal Investigator	Jianquan Wang, MD, PhD
PI Primary Affiliation	Peking University Third Hospital
Co-Investigator(s)	Shuang Ren, PhD; Hongshi Huang, MD, PhD; Xi Gong, MD, PhD; Hui Yan, MD, PhD; Zheng Zhou; Xin Miao; Na Cui;

PROJECT DESCRIPTION

This project aims to develop an intelligent home-based digital rehabilitation system for elderly patients with knee osteoarthritis and frozen shoulder, addressing limitations in current home rehabilitation such as lack of personalization, inaccurate assessment, and absence of real-time supervision. The system integrates wearable sensors, machine vision, and intelligent agents to provide personalized exercise prescriptions, real-time motion correction, quantitative functional assessment, and risk alerts. A multimodal database will be established, incorporating medical records, imaging, sensor data, and patient-reported outcomes. Using retrieval-augmented generation and reinforcement learning, the system dynamically optimizes rehabilitation plans. A prospective randomized controlled trial will validate its efficacy and safety. The goal is to enhance rehabilitation outcomes, reduce medical resource pressure, and support healthy aging.

Novel SMDC Drug for Precision Chemotherapy of Tumors

Principal Investigator	Jiuming He, PhD
PI Primary Affiliation	Institute of Materia Medica, Chinese Academy of Medical Sciences and Peking Union Medical College
Co-Investigator(s)	Yan Li, PhD; Kaijing Guo, MS; Jianpeng Huang, MS; Dongting Chen, MS

PROJECT DESCRIPTION

A novel small-molecule drug conjugate (SMDC) born from an original target and a unique mechanism, was designed to tackle refractory solid tumors like pancreatic cancer and glioblastoma. Its core advantages include: 1) Superior Efficacy: It demonstrates significantly higher tumor inhibition and survival extension than nab-paclitaxel in various challenging animal models. 2) Revolutionary Safety: Its tumor-specific activation mechanism drastically reduces systemic, immunogenic, and neurotoxicities, promising improved patient quality of life. 3) Dual-Targeting Delivery: It combines active targeting via a metabolism-associated transporter with passive targeting through nanomicelles, ensuring precise tumor accumulation. 4) Overcoming Clinical Barriers: It effectively penetrates the blood-brain barrier and dense tumor stroma, addressing the key limitation of poor solid tumor penetration seen with larger entities like ADCs. This SMDC aims to meet the urgent, high-unmet medical need in aggressive cancers with poor prognoses and limited therapeutic options, such as pancreatic cancer (median survival <1 year), glioblastoma, and chemotherapy-resistant lung cancer.

Precise Preparation of Chitosan-Based Functional Hydrogels and Their Effect on Treating Chronic Wounds in the Elderly

Principal Investigator	Dongfeng Zhang, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Ya Liu, PhD

PROJECT DESCRIPTION

When elderly individuals become bedridden due to chronic illness and are unable to perform self-care, the incidence of related refractory wounds, such as diabetic foot ulcers and pressure injuries, subsequently rises significantly. Chitosan is the sole natural cationic polysaccharide extracted from the shells of marine crustaceans, which has good biocompatibility, strong hemostatic and antibacterial ability, and is often regarded as the preferred raw material for the preparation of hydrogel medical dressings. However, due to the complex composition and disordered structure of chitosan, the gelation performance of hydrogel is not accurate, the microstructure is not clear, and the stability and repeatability of related experimental results are controversial, which cannot meet the requirements of precise control for refractory wounds. Aiming at the bottleneck of the development of marine chitosan industry and the technical problem of sticking neck in the development of wound dressing, this project establishes a high-quality chitosan preparation and homogeneous modification technology with precise structure. To form an innovative technology system for the application and development of marine chitin from random distribution of raw material structure sequence to orderly, from uneven reactivity of modification sites to uniform, and to develop a novel type of marine chitin thermosensitive hydrogel wound repair material with clear structure, precise phase change and clear mechanism. The development of this project will promote the upgrading of biomedical dressing industry, promote scientific and technological innovation to cope with aging and achieve active health.

Preclinical Study on IMBZ19G, a Class 1 Innovative Antibiotic Against Gram-negative Drug-resistant Bacteria

Principal Investigator	Yinghong Li, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Danqing Song, PhD; Xi Lu, PhD; Yonghua Liu, PhD; Xican Ma, PhD;

PROJECT DESCRIPTION

Multidrug-resistant (MDR) Gram-negative bacteria pose a significant global public health threat. Compounding the issue, no drugs with novel mechanisms of action or new chemical scaffolds have been approved worldwide over the past four decades, leaving substantial unmet clinical needs. IMBZ18G, a Class 1 novel monocyclic β -lactam drug independently developed by our team, demonstrates outstanding in vitro and in vivo efficacy against clinically prevalent, intractable infections caused by MDR Enterobacteriaceae, and possesses favorable druggability profiles. Mechanistically, it simultaneously binds to penicillin-binding proteins 3 (PBP3) and 1B (PBP1B), and exhibits high stability against Class A, B, C, and D β -lactamases. IMBZ18G is currently undergoing Phase I clinical trials in China. Furthermore, its combination formulation with avibactam (a β -lactamase inhibitor), designated IMBZ19G, outperforms Pfizer's newly approved aztreonam-avibactam for the treatment of severe infections caused by MDR Gram-negative bacteria, underscoring its extensive clinical application potential. Our future research efforts will focus on establishing price competitiveness ahead of its commercial launch by optimizing the synthetic process of IMBZ18G, and expediting the preclinical development of IMBZ19G to secure its Investigational New Drug (IND) application acceptance. This project is expected to provide a promising therapeutic option for the treatment of MDR Gram-negative bacterial infections, as well as novel insights into the underlying mechanisms, thereby improving the prognosis of patients with such infections.

Research and Development of Jolkinolide B for the Treatment of Chronic Kidney Disease

Principal Investigator	Kang Ding, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Weiku Zhang, PhD; Jiekun Xu, PhD; Jun He, PhD; Yu Yan, PhD

PROJECT DESCRIPTION

Chronic kidney disease (CKD) is a complex clinical syndrome caused by various reasons, which lasts for more than three months with abnormal renal structure or function and various related metabolic disorders. Its harm is serious, and the incidence rate is increasing year by year. At present, there are no targeted treatment measures for CKD, and clinical treatment mainly adopts strategies such as controlling the primary disease, eliminating risk factors, and symptomatic treatment to treat CKD. It is urgent to develop new therapeutic drugs for CKD. Our team's research found that jolkinolide B in *Euphorbia fischeriana* Steud. exhibited significant anti-inflammatory and anti-renal fibrosis effects. It can effectively reduce renal inflammation, decrease collagen fiber deposition in renal interstitium, alleviate renal tubular dilation, delay renal fibrosis, and alleviate renal pathological damage. At present, the extraction and separation process in the laboratory can obtain jolkinolide B with a purity greater than 99%. Furthermore, in the single dose toxicity test on mice, jolkinolide B has a high level of safety. Our team will conduct research on the pharmacy, pharmacology, pharmacokinetics, and safety evaluation of jolkinolide B in accordance with the requirements of the Drug Registration Management Measures, improve the preclinical research of jolkinolide B raw materials and preparations, and lay the foundation for its development as a therapeutic drug for CKD.

Research and targeted therapy of age-related pulmonary fibrosis

Principal Investigator	Ting Dong, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Ruijuan Gao, PhD

PROJECT DESCRIPTION

Confronting the severe challenge of accelerating global population aging, aging-associated pulmonary fibrosis presents a critical dual public health threat, while existing therapeutics such as pirfenidone and nintedanib only slow disease progression without reversing fibrosis; this underscores an urgent need for breakthrough therapies targeting core pathological mechanisms with dual anti-aging and anti-fibrotic efficacy. Building upon our original discovery that disrupted vimentin proteostasis constitutes a central driver of fibroblast senescence and pulmonary fibrosis—wherein aberrant aggregation compromises cytoskeletal integrity and induces profibrotic secretory phenotypes—this project aims to develop innovative strategies targeting proteostasis regulation. We employ a dual-track approach integrating chemical and classical genetics: firstly, optimizing lead compound 9-85 to develop molecules that selectively degrade pathogenic vimentin aggregates while elucidating their mechanism involving CCT2 recruitment for autophagic clearance; secondly, deciphering the cooperative mechanism by which the Calumenin-TRiC (TCP-1 ring complex) chaperonin complex promotes vimentin correct folding to reveal the pathological cascade of aberrant aggregation. Integration of both tracks will map the dynamic vimentin folding-degradation regulatory network, yielding 1-2 preclinical candidate compounds capable of reversing fibrosis and cellular senescence, generating 1–2 core patents, and pioneering the world's first proteostasis-targeting anti-aging therapy. The project leverages robust preliminary foundations, including our team's validation of vimentin aggregation's pathogenic role, active compound 9-85 with established structure-activity relationship (SAR) data, and dedicated platforms for proteostasis research, aging-associated pulmonary fibrosis animal models, and clinical specimen biobanks, providing comprehensive support to overcome current therapeutic limitations.

Research on Disposable Patch-Type Intelligent Ultrasound Monitoring Technology for Bladder Volume and Development of Corresponding Instrument

Principal Investigator	Pengfei NIU, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Sheng ZHOU, PhD; Huimin LI, MS; Yuan WANG, MS; Wei WEI, MS; Zhiyuan ZHAO, MS

PROJECT DESCRIPTION

The population affected by bladder dysfunction is substantial. Catheters are invasive and prone to cause infections, while traditional ultrasound monitoring relies on manual operation, making it difficult to meet the needs of intelligent care in multiple scenarios. Consequently, there is an increasingly urgent clinical demand for continuous non-invasive monitoring of bladder volume. This project is to develop an intelligent ultrathin ultrasound patch to monitor bladder volume, with the vision to be used for scenarios such as postoperative rehabilitation, home care and so on. It is implemented with piezoelectric micromachined ultrasonic transducer (PMUT), which is developed by micro-electro-mechanical system (MEMS) technology and holds advantages of ultra-compact size, low power consumption and low cost. These characteristics enable the miniaturization as well as disposability of wearable ultrasound patch, which well favors its wide application among patients. To this end, one of our focuses is to reveal the quantity as well as the arrangement of PMUT chips required on the wearable patch for accurately calculating the bladder volume during the entire urine filling process. Moreover, great efforts are made on the development of effective intelligent algorithms to precisely form the three dimensional shape of the bladder with various amount of urine with the sensed bladder walls. Collaborative optimization of hardware

and algorithms is done to achieve exact urine volume in real time. Then reliable integration of rigid silicon chips within flexible and stretchable matrix is unveiled to form ultrathin wearable patch. Our aim is to move bladder monitoring toward intelligent wearable solutions.

Research on the Development and Clinical Promotion & Application of the Jianpi Yiwei Formula as a Novel Chinese Medicine for Treating Chemotherapy-Induced Gastrointestinal Reactions

Principal Investigator	Jiayang Chen, MD, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Li Feng, MD, PhD; Peizhi Ye, MD; Xinrui Hu, MS; Xinqi Liu, MS; Ning Du, MS; Qiyuan Mao, MD

PROJECT DESCRIPTION

Chemotherapy-induced gastrointestinal reactions significantly impact patients' quality of life and survival, with nausea and vomiting being the most prevalent symptoms. Routine prophylactic use of antiemetics like 5-HT₃ receptor antagonists achieves a high efficacy rate of approximately 70%–84%. However, patients responding to antiemetic therapy may still experience symptoms such as loss of appetite, nausea, bloating, and constipation during chemotherapy, highlighting the limitations of modern medical approaches in providing holistic management.

Our team has developed the patented Chinese herbal formula Jianpi Yiwei Formula (ZL202210097886.0) for chemotherapy-induced gastrointestinal reactions. Preliminary clinical results show an overall efficacy rate of 85% in alleviating these symptoms. Standardized granule preparation has been completed, including studies on manufacturing, pharmacodynamics, quality control, and stability. Preliminary research indicates that modulating the "inflammation-gut microbiota axis" is its core mechanism.

This project aims to build on prior findings by completing toxicology studies, obtaining robust clinical efficacy evidence through standardized trials, and exploring mechanisms via patient samples. The goal is to establish a closed-loop R&D and clinical application framework for Jianpi Yiwei Formula—ensuring quality control, confirmed efficacy, and clarified mechanisms.

Research on the Mechanism and Application of Eradicating Biofilms by Coordination Regulation of Bimetallic Nanoenzymes

Principal Investigator	Mingmei Li, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Xiang Zheng, PhD

PROJECT DESCRIPTION

Biofilm infections on prosthetic joints pose a major clinical challenge, with current treatments often being highly invasive and having high recurrence rates. While single-atom nanozymes show promise for anti-biofilm therapy due to their atomically dispersed active sites and enzyme-like catalysis, their clinical translation is limited by low substrate affinity and slow kinetics. This project aims to overcome these limitations by developing an injectable dual-atom nanozyme hydrogel. We will employ a coordination regulation strategy to create dual-atom sites, enabling synergistic photothermal and multi-enzyme catalytic activities. Our research will: (1) Uncover the atomic-level synthesis mechanism of the nanozymes. (2) Decipher how the electronic structure regulates H₂O₂/O₂ adsorption and activation, elucidating the photothermal-catalytic synergy and controlled ROS

generation. (3) Systematically evaluate the hydrogel's biofilm eradication efficacy and biosafety through in vitro and in vivo models. This study seeks to provide a novel, clinically viable solution for prosthetic joint infections.

Reversing Immune Aging through Intermittent Hypoxic Training

Principal Investigator	Jun Yan, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Diangeng Li, PhD; Sijie Li, MD; Youliang Sun, PhD; Zechao Gao, MS; Cong Li, PhD Candidate; Wenqin Wang, PhD Candidate

PROJECT DESCRIPTION

Immunosenescence, the age-related decline in immune function, is a major driver to systemic aging, increasing susceptibility to infections, reducing vaccine efficacy, and elevating the risk of age-related diseases. Key hallmarks include skewed hematopoietic stem cell (HSC) differentiation, thymic atrophy, and chronic inflammation. The hypoxic microenvironment has emerged as a critical yet poorly understood regulator of this process. Although hypoxia can bidirectionally modulate aging and immunity through metabolic, epigenetic, and inflammatory pathways, its systemic effects and therapeutic potential remain largely unexplored, with current evidence primarily derived from in vitro studies. This project aims to systematically investigate the potential of intermittent hypoxia (IH) to reverse immunosenescence in vivo. We will establish an IH training protocol in aged mice to comprehensively assess its effects on key immunological parameters. Specifically, we seek to determine the impact of this intervention on bone marrow HSC aging, T-cell receptor (TCR) repertoire diversity, and the capacity to generate effective vaccine responses. Furthermore, we will elucidate the underlying molecular mechanisms by which IH attenuates HSC aging and chronic inflammation while promoting lymphoid differentiation. To facilitate clinical translation, the project will also develop a smart, patented device for safe and personalized delivery of IH training, and evaluate the effect of hypoxia preconditioning on vaccine response rates in elderly human subjects, thereby establishing a direct foundation for translational application. This research aims to provide a robust theoretical basis for the development of hypoxic adaptation-based immune interventions against aging, with significant scientific and clinical implications for promoting healthy aging.

Sentinel Rapid Test for Prostate Cancer-Clinical Application and Promotion of a New Approach to Prostate Cancer Screening

Principal Investigator	Tao Wang, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Xuegang Wang, PhD, MD; Bing Guan, PhD, MD

PROJECT DESCRIPTION

Prostate cancer (PCa) is the second most commonly diagnosed malignancy among men worldwide and the incidence and mortality rates of prostate cancer in China have been rising annually. There is an urgent need for integrated technological breakthroughs to establish a precise screening system covering the entire disease course of prostate cancer, aiming to achieve early detection, simplify diagnostic procedures for advanced cases, and enable identification of the neuroendocrine transformation (NEPC) subtype. Based on our previous work, we will integrate SERS-based rapid PSA testing, SPR-based detection of PSA, CD63-sEV, and PSMA-sEV, as well as the development of an SV2A-targeted probe for NEPC. Through prospective multi-center cohort studies, we will validate the clinical efficacy of these three technologies. Ultimately, we aim to establish a pioneering three-tier screening model of "SERS Rapid Test-Exosome Sensing-SV2A Imaging". This model will overcome three major clinical bottlenecks: insufficient sensitivity in early detection, reliance on invasive methods in advanced stages, and the lack of diagnostic tools for NEPC. By doing so, it will promote early screening, diagnosis, and

treatment of prostate cancer, advance precision medicine, extend patient survival, improve quality of life, and contribute to the national strategy for health and longevity.

Study on smart-responsive antibacterial and mitochondria-targeted hydrogel for promoting diabetic wound healing

Principal Investigator	Wenshuai Liu, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Weiwei Wang, PhD; Litao Jia, PhD; Yifei Li PhD

PROJECT DESCRIPTION

Diabetic wound repair forms a vicious cycle due to three major pathological factors: bacterial infection, persistent inflammation, and impaired angiogenesis. Moreover, the formation of drug-resistant bacterial biofilms and the accumulation of mitochondrial reactive oxygen species further exacerbate the condition, while traditional dressings have limited efficacy, making it a key challenge in clinical treatment. Amid the trends of biomedical material innovation and the development of wound treatment technologies, developing novel dressings with multiple synergistic therapeutic functions has become an effective path to break through the bottleneck of diabetic wound repair, and also provides an important direction for addressing clinical treatment dilemmas. This study focuses on the key technologies of intelligent bioactive hydrogels, constructs a new wound repair system through molecular and structural synergistic design: a mitochondrial-targeted liposome delivery system for endothelial cells is established to scavenge mitochondrial reactive oxygen species and improve endothelial cell function; meanwhile, matrix metalloproteinase-responsive chemical bonds are utilized to achieve controlled release of antimicrobial peptides, synchronously realizing antibacterial, anti-inflammatory, and pro-angiogenic effects; in addition, a bionic strategy is adopted to construct a three-dimensional porous network that simulates the extracellular matrix, supporting cell adhesion and tissue regeneration to facilitate the wound repair process. The research team aims to provide a new type of dressing for diabetic wound treatment, control the key risk factors of wound repair through technological innovation, improve the wound healing quality of diabetic patients, and offer strong support for promoting technological progress and clinical transformation in the field of wound repair.

Study on the transformation of multi-parameter fusion gastrointestinal function monitoring system based on bowel sounds in critically ill patients

Principal Investigator	Jun Xu, PhD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Shengyong Xu, PhD; Jing Yang, PhD; Yang Liu, PhD; Hanqi Tang, PhD

PROJECT DESCRIPTION

Changes in gastrointestinal function in critically ill patients hold crucial indicative significance in the assessment of the overall disease treatment and prognosis. Bowel sounds, as an important non-invasive clinical means for monitoring gastrointestinal functional changes, currently mainly rely on auscultation, which suffers from drawbacks such as strong subjectivity, low precision, and poor scientific rigor, thereby limiting the effective clinical application of bowel sound monitoring. Therefore, this project aims to develop a multi-parameter fusion gastrointestinal function monitoring system for critically ill patients based on bowel sounds. This system enables the objective and accurate acquisition of bowel sounds. Meanwhile, by integrating vital sign parameters such as heart rate, pulse, respiration, peripheral perfusion based on pulse, and blood pressure, it establishes alarm thresholds and ranges for the overall direction of gastrointestinal functional changes. The system is characterized by continuous monitoring, non-invasiveness, portability, and low cost. It assists clinicians in

enhancing the accuracy of predicting the direction of gastrointestinal functional changes in critically ill patients, providing a reliable basis for continuous dynamic monitoring and early intervention in clinical settings.

The Development and Application of the Second-Generation Fully Automated 3D Breast Ultrasound Equipment in Breast Cancer Screening

Principal Investigator	Yong Wang, MD
PI Primary Affiliation	Chinese Academy of Medical Sciences
Co-Investigator(s)	Jie Han, MD; Rui Zhang, MD; Ningyi Cui, MD; Li Feng, MD; Zhiguang Hu, MM; Maoran Li, MM; Jie Zhang, MM; Yun Dai, MM; Mengjia Liu, MD; Wuwan Wang, MD; Chao Sun, MD; Di Yang, MD; Yu He, MM

PROJECT DESCRIPTION

Introduction: Chinese women predominantly have dense breast tissue. Traditional ultrasound examinations are plagued by strong operator dependence, insufficient diagnostic homogenization, and a shortage of professional physicians, which limit the effectiveness of breast cancer screening and diagnosis. Meanwhile, existing automated

breast ultrasound devices face bottlenecks such as complex operation, long examination time, and high costs. This project aims to develop the second-generation fully automated 3D breast ultrasound equipment with independent intellectual property rights to address the aforementioned issues, improve screening efficiency and accuracy, and meet the needs of breast cancer prevention and treatment in China.

Objective: Our primary objective is to develop the second-generation fully automated 3D breast ultrasound equipment to enhance diagnostic efficacy and demonstrate that its detection rate and diagnostic accuracy for breast nodules are non-inferior to those of traditional handheld ultrasound. The secondary objective is to compare the size of nodules detected by the two technologies and the time consumed for examination.

Technical Scheme: Instrument development: Improve the ultrasound image quality by optimizing the automated examination process and reducing image noises, and optimize the 3D reconstruction algorithms to reduce image distortion and achieve full-breast 3D visualization.

Basic Conditions: The applicant unit, Cancer Hospital of the Chinese Academy of Medical Sciences, is a national-level cancer prevention and treatment center with advanced equipment and research platforms. The collaborating unit, CompAI Medical Technology (Suzhou) Co., Ltd., has rich experience in breast equipment research and development.

Therapeutic Strategies for Knee Diagnosis and Treatment Protocol Based on Stage-specific Pathogenesis Development of a Whole-cycle Precision Assessment System and Novel Osteoarthritis: A Stepped Precision

Principal Investigator	Yingjie Wang, PhD
PI Primary Affiliation	Chinese Academy of Medical Science
Co-Investigator(s)	Xisheng Weng, MD; Bin Feng, MD; Jibin Song, PhD

PROJECT DESCRIPTION

Knee osteoarthritis (KOA) is often diagnosed in the middle to late stages, where current staging and treatment struggle to achieve early identification and precise intervention. Our team, based on the discovery of key molecules in chondrocyte phenotypic transition, focuses on dual cores of chondrocyte/synovial/ subchondral bone cell senescence and immune microenvironment imbalance. We propose a "Symptom-Imaging-Function

(SIF)" staging and conduct staged "anti-inflammatory-regenerative" therapy. Innovations include precise SIF staging, functional apoptotic bodies, organoid microenvironment platforms, and animal validation. Collaborating with Peking Union Medical College Hospital and the State Key Laboratory of Beijing University of Chemical Technology, dual PIs manage the project.

“AI-Heal Companion”: Establishment of a LLM-based Postoperative Management Platform for Elderly Lung Cancer Patients

Principal Investigator	Shanqing Li, MD
PI Primary Affiliation	Peking Union Medical College Hospital, Chinese Academy of Medical Sciences
Co-Investigator(s)	Chao Guo, MD; Huizhen Jiang, MS; Libing Yang, MD

PROJECT DESCRIPTION

Lung cancer has the highest incidence and mortality among malignancies in China, and most patients are older adults. Postoperative management in this population is challenged by multiple comorbidities, poor adherence, and inappropriate medication use. Existing follow-up models rely mainly on manual work, with fragmented information that makes it difficult to achieve continuous, closed-loop management across inpatient and outpatient settings. This project aims to build an intelligent, large-language-model–driven management platform to provide collaborative care for older patients after lung cancer surgery. First, we will construct a multimodal database covering the full care pathway from preoperative evaluation to long-term follow-up. On this basis, we will develop a lung-cancer–specific large language model that deeply integrates clinical knowledge and advanced reasoning capabilities, and create two innovative engines for individualized postoperative risk sensing and multidisciplinary knowledge fusion. Finally, we will design a mobile application with clinician and patient interfaces tailored to older adults’ usage habits, and evaluate its safety, feasibility, and clinical benefits through prospective clinical studies. By breaking the barriers between in-hospital treatment and out-of-hospital rehabilitation and enhancing the efficiency and precision of postoperative management, this project seeks to provide a scalable, intelligent new pathway for “chronic disease–oriented” postoperative care of cancer patients in China.