(17)

遠距醫療數位轉型與永續發展

The Intersection of Homehospital and Sustainable Development Goals

時　　間：113 年 6 月 22 日(星期六) 13:30~17:30
地　　點：臺北榮民總醫院 致德樓第四會議室

13:30-13:35	***Opening Remarks***	余文鍾教授 Wen-Chung Yu
	座長：余文鍾 教授 (Wen-Chung Yu)	
13:35-13:55	人工智慧浪潮來襲，我們的機會在哪裡? As The Wave of Artificial Intelligence Sweeps In, Where Do Our Openings Await?	杜奕瑾董事長 I-Chin Tu
	座長：謝育整 教授 (Yu-Cheng Hsieh)	
13:55-14:10	無縫醫療：整合穿戴裝置與人工智慧打造連續病患監護 Seamless Healthcare: Integrating Wearable Devices and Artificial Intelligence to Provide Continuous Patient Monitoring	張世霖教授 Shih-Lin Chang
	座長：宋思賢 教授 (Shih-Hsien Sung)	
14:10-14:25	由 AI 引領的心臟電生理學：從心電圖到心內電圖的心律不整新視野 AI-Led Cardiac Electrophysiology: New Perspectives from Electrocardiograms to Intracardiac Electrograms Arrhythmias	羅孟宗教授 Men-Tzung Lo
	座長：羅孟宗 教授 (Men-Tzung Lo) **黃金洲 教授 (Chin-Chou Huang)**	
14:25-14:57	***心血管創新成果發表—以 AI 創造醫療永續發展***	
	心電圖 AI 診斷系統 (8 min) ECG AI Prediction Systemt (8 min)	劉至民醫師 Chih-Min Liu
	冠狀動脈 AI 預測系統 (8 min) CAD AI Prediction System (8 min)	黃偉杰醫師 Wei-Chieh Huang
	AI 輔助生理訊號預測不良事件之發生 AI Enabled ECG Signal System to Predict CV Event (8 min)	張珽詠醫師 Ting-Yung Chang
	智能藥師：遠距醫療的 AI 助理 Intelligent Pharmacist: AI Assistant in Telemedicine (8 min)	翁如潔藥師 Ju-Chieh Wung
14:57-15:15	***Panel Discussion***	周千瀅主任 Chian-Ying Chou 趙子凡教授 Tze-Fan Chao 段大全主任 Ta-Chuan Tuan

15:15-15:20	***Closing Remarks***	陳文鍾教授 Wen-Jone Chen
15:20-15:35	***Coffee Break***	

國科會心臟學門優秀計畫成果發表

National Science and Technology Council 's Excellent Project Results Presentation in Cardiology

15:35-15:40	***Opening Remarks***	張世霖教授 Shih-Lin Chang
	座長：葉宏一 教授 (Hung-I Yeh)	
15:40-15:55	心房顫動相關之血栓性中風的全基因組關聯性研究 Genetic Predictors for Atrial Fibrillation Related Stroke	蔡佳醍教授 Chia-Ti Tsai
	座長：盧澤民 教授 (Tse-Min Lu)	
15:55-16:10	內皮前驅幹細胞（EPC）治療心臟血管疾病的進展 Endothelial Progenitor Cell in Treatment of Cardiovascular Disease	黃柏勳教授 Po-Hsun Huang
16:10-16:25	***Panel Discussion***	呂信邦教授 Hsin-Bang Leu 吳道正主任 Tao-Cheng Wu
	座長：陳嬰華 教授 (Ying-Hwa Chen)	
16:25-16:40	人類多能性幹細胞衍生的心肌細胞於心臟再生研究的進展 Cardiac Regeneration Research Using Human Pluripotent Stem Cell-Derived Cardiomyocytes	胡瑜峰教授 Yu-Feng Hu
	座長：葉勇信 教授 (Yung-Hsin Yeh)	
16:40-16:55	運用心臟超音波的機器學習模型預測死亡率 Development and Validation of Echocardiography-Based Machine-Learning Models to Predict Mortality	洪崇烈教授 Chung-Lieh Hung
	座長：鄭浩民 教授 (Hao-Min Cheng)	
16:55-17:10	應用人工智慧深度學習於心血管疾病與個體化差異關聯性研究 Application of AI in Cardiovascular Disease	劉秉彥教授 Ping-Yen Liu
17:10-17:25	***Panel Discussion***	許百豐主任 Pai-Feng Hsu 吳承學主任 Cheng-Hsueh Wu
17:25-17:30	***Closing Remarks***	余文鍾教授 Wen-Chung Yu

As the wave of artificial intelligence sweeps in, where do our openings await?

人工智慧浪潮來襲，我們的機會在哪裡？

I-Chin Tu
杜奕瑾
Founder, Taiwan AI Labs
臺灣人工智慧實驗室

Large Language Models (LLMs) play a transformative role in healthcare by enhancing medical knowledge, supporting patient care, and optimizing communication. By leveraging vast datasets and deep learning techniques, LLMs can comprehend, summarize, and create medical content, thereby aiding in medical education and decision-making processes. Taiwan AI labs is pioneering the global AI landscape through its unique trustworthy AI evaluation system. By leveraging these endeavors, we now present FedGPT that is the foremost federated healthcare solution to enable a broad spectrum of applications in the hospitals. FedGPT empowers a smart medical system by integrating vast arrays of electronic health records (EHRs), medical images, genomic data, and clinical guidelines. Our discourse will focus on FedGPT's transformative functions, including its capacity for converting speech into structured documentation, augmenting diagnostic accuracy with multimodal AI, and ensuring compliance and disease coding. With accumulated efforts on understandings of over 37 million biomedical literature, we further leverage LLMs to strengthen disease prevention and health education efforts. More importantly, FedGPT applies federated technologies that can redefine data utility via open access to foster breakthroughs in personalized medicine research and healthcare operation efficiency. We invite you to join us in exploring the revolutionary impact of FedGPT as a new era of intelligent healthcare solutions.

Seamless healthcare: Integrating wearable devices and artificial intelligence to provide continuous patient monitoring

無縫醫療：整合穿戴裝置與人工智慧打造連續病患監護

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AIOT (Artificial Intelligence of Things) in telehealthcare refers to the integration of artificial intelligence (AI) and Internet of Things (IoT) technologies in the field of telehealth. Telehealthcare combines telecommunication and healthcare to provide remote diagnosis, monitoring, and treatment to patients, enabling healthcare professionals to deliver care from a distance. AIOT in telehealthcare of cardiac arrhythmia brings several advantages and opportunities: remote patient monitoring, predictive analytics, virtual consultations and diagnosis, treatment optimization, telemedicine robotics, data security and privacy.

While AIOT in telehealthcare of cardiac arrhythmia offers numerous benefits, challenges exist. These include ensuring interoperability between different IoT devices, addressing concerns about data privacy and security, integrating AI algorithms seamlessly into existing healthcare workflows, and maintaining ethical use of AI to avoid biases and ensure transparency in decision-making. AIOT has a potential to transform telehealthcare by enhancing patient care, improving diagnosis accuracy, enabling remote monitoring, and optimizing treatment strategies.

AI-Led cardiac electrophysiology: New perspectives from electrocardiograms to intracardiac electrograms arrhythmias

由 AI 引領的心臟電生理學：從心電圖到心內電圖的心律不整新視野

Men-Tzung Lo

羅孟宗

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Atrial fibrillation (AF) isn't always triggered by a completely random process. Stable and rapid re-entrant circuits, leading to fibrillatory conduction throughout the atria, can persist for minutes, or even hours. Ablation targeted at the center of stable rotating waves and focal sources has shown a high rate of acute AF termination and improved long-term recurrence-free probability. However, in mapping the atrial substrate electrograms of AF, a common challenge is identifying culprit sites and analyzing wave propagation, especially for electrogram signals with significant temporal and spatial disparities. Localizing AF drivers using conventional sequential temporal-spatial mapping in persistent AF is even more challenging due to the lack of specificity of complex atrial electrograms, intermittent firing, and spatial meandering.

In my presentation, I will introduce newly developed systems featuring a multiple channels amplifier frontend, compatible with various types of catheters, and capable of achieving optimal computing efficiency for real-time ultra-high density mapping of atrial substrates through heterogeneous computation. These systems have the ability to interpret complex wave propagation and identify the substrate maintaining AF through Artificial Intelligence, thereby aiding in uncovering the true AF driver hidden beneath highly fragmented waves. My presentation will systematically compare automated electrogram analysis using real-time ultra-high density substrate mapping. This comparison aims to facilitate a better understanding of why these approaches enable instantaneous and objective identification of abnormal potentials accurately indicating AF drivers. It is noteworthy that these methods not only reduce the ablation area but also improve the acute termination rate and recurrence-free survival of AF.

ECG AI prediction system

心電圖 AI 診斷系統

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The prevalence of pulmonary hypertension is approximately 1%, affecting over 25 million patients globally. Among these, those with pulmonary pressures exceeding 50mmHg face a five-year mortality rate greater than 30%. Early detection and treatment to prevent deterioration are essential. However, early symptoms are often overlooked, and the lack of accurate screening tools delays treatment, thereby increasing the risk of mortality. This issue is global, and the FDA has included one pulmonary pressure detection system in its Breakthrough Devices Program to accelerate its development.

The Pulmonary Hypertension Detection system (PHD) is an AI-assisted diagnostic ECG software designed for screening pulmonary hypertension. It is the first system of its kind to undergo multinational and multi-center international testing, including in Taipei and Taichung Veterans General Hospitals, National Cheng Kung University Hospital in Taiwan, and Makiminato Central and Nakagami Hospitals in Japan. The AI has demonstrated stable validation results, allowing rapid screening and providing diagnostic probabilities for pulmonary hypertension, thus aiding physicians in diagnosis. The diagnostic accuracy of this software is nearly three times greater than that of traditional ECG interpretations by physicians, significantly enhancing early diagnosis rates. The system has been internationally published and patented. The PHD system can be widely applied in hospitals, clinics, and health screening centers, requiring only a simple personal computer setup with ECG equipment to perform screenings, and provides results within 5-10 minutes. It can also operate remotely, enabling transnational ECG analysis. Currently, it is being industrially applied in collaboration with companies and has applied for TFDA approval as a medical device software.

CAD AI prediction system

冠狀動脈 AI 預測系統

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Leveraging patient data through machine learning techniques in disease care offers a multitude of substantial benefits. Nonetheless, the inherent nature of patient data poses several challenges. Prevalent cases amass substantial longitudinal data owing to their patient volume and consistent follow-up, however, longitudinal laboratory data are renowned for their irregularity, temporality, absenteeism, and sparsity; In contrast, recruitment for rare or specific cases is often constrained due to their limited patient size and episodic observations. This study employed self-supervised learning (SSL) to pretrain a generalized laboratory progress (GLP) model that captures the overall progression of six common laboratory markers in prevalent cardiovascular cases, with the intention of transferring this knowledge to aid in the detection of specific cardiovascular event.

GLP implemented a two-stage training approach, leveraging the information embedded within interpolated data and amplify the performance of SSL. After GLP pretraining, it is transferred for target vessel revascularization (TVR) detection.The proposed two-stage training improved the performance of pure SSL, and the transferability of GLP exhibited distinctiveness. After GLP processing, the classification exhibited a notable enhancement, with averaged accuracy rising from 0.63 to 0.90. All evaluated metrics demonstrated substantial superiority ([Formula: see text]) compared to prior GLP processing. Our study effectively engages in translational engineering by transferring patient progression of cardiovascular laboratory parameters from one patient group to another, transcending the limitations of data availability. The transferability of disease progression optimized the strategies of examinations and treatments, and improves patient prognosis while using commonly available laboratory parameters. The potential for expanding this approach to encompass other diseases holds great promise. Our study effectively transposes patient progression from one cohort to another, surpassing the constraints of episodic observation. The transferability of disease progression contributed to cardiovascular event assessment.

Keywords: Cardiovascular diseases; cardiometabolic disease; disease progression; laboratory examinations; pre-train model; representation learning; self-supervised learning; time-series data; transfer learning.

AI enabled ECG signal system to predict CV event

AI 輔助生理訊號預測不良事件之發生

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Atrial fibrillation (AF), the most common arrhythmia in clinical practice, carries the potential for blood stasis and increased likelihood of thrombus formation, resulting in a higher risk of stroke and thromboembolism. The prevalence of AF is projected to be 4% in 2050, while the lifetime risk is approximately 1 in 7 for subjects aged ≥20 years. AF increases the risk of ischemic stroke, dementia, heart failure, myocardial infarction, and mortality. However, screeningof AF remains challenging, and underdiagnosis is commonin patients with paroxysmal AF (pAF) due to their highprevalence of asymptomatic AF. Subclinical AF is one of thepathogeneses of embolic stroke of an undetermined source(ESUS). Thus, early detection of occult AF is of paramount importance, in order to improve patient management. Timely diagnosis allows the implementation of appropriate interventions, either pharmacological or interventional, in order to prevent adverse effects, reducing morbidity and mortality. Implantable loop recorders have drawbacks, since their cost may hinder their implementation in certain healthcare systems. Moreover, adverse events, such as skin erosion, infections, device oversensing or undersensing can limit their effectiveness.Traditional methods of arrhythmia screening, such as electrocardiography (ECG) and continuous ambulatory Holter monitoring are mainly hampered by the limited period of rhythm recordings.

To increase the diagnostic rate of ECG monitoring and its cost-effectiveness, it is necessary to choose a patient who is expected to have AF. Artificial intelligence might be useful to predict adverse events, such as paroxysmal AF or VT in patients who showed sinus rhythm during 24-h Holter monitoring.The results of application of AI in digital heath should be interpreted very carefully to avoid possible bias and must be tested in RCTs.The combination of wearables with telemedicine might also lead to a revolution in community care, as well as a reduction in both acute hospital admission and health spending.

Intelligent pharmacist: AI assistant in telemedicine

智能藥師：遠距醫療的 AI 助理

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The COVID-19 pandemic has accelerated the integration of telemedicine as a standard healthcare service model. Traditional face-to-face interactions between medical professionals and patients have transitioned to those on digital screens, providing the foundation for the development of a diverse array of AI-powered medical tools, with a particular focus on image reading.

Our project focuses on image reading for prescriptions, which are displayed on video screens by patients during telemedicine consultations. Drug names are extracted using optical character recognition technology and converted into unique identification codes, such as international drug codes or medication license numbers, by referencing government open data sources. These identification codes undergo another round of matching with the patients' drug records from national health insurance or healthcare units, resulting in the automatic generation of intelligent pharmacist service documents. These documents offer support to medical personnel in delivering clinical pharmacy care.

This system is built upon well-established technologies, minimizing both development costs and time-to-market, while efficiently utilizing government open data resources to reduce expenses associated with database maintenance. By integrating AI-assisted clinical pharmacy services, our system effectively reduces pharmacist workloads, minimizes medication wastage, and decreases the risk of potential adverse drug events, ultimately enhancing the overall quality of healthcare delivery. This innovative approach not only optimizes healthcare processes but also upgrades patient safety and satisfaction within the evolving landscape of telemedicine.

Genetic predictors for atrial fibrillation related stroke

心房顫動相關之血栓性中風的全基因組關聯性研究

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Atrial fibrillation (AF) is a common cardiac arrhythmia and is one of the major causes of ischemic stroke. In addition to the clinical factors such as CHADS2 or CHADS2-VASC score, the impact of genetic factors on the risk of thromboembolic stroke in patients with AF has been largely unknown. Single-nucleotide polymorphisms (SNPs) in several genomic regions have been found to be associated with AF susceptibility. However, whether SNPs in other genomic regions are associated with AF-related thromboembolic stroke are unknown. Therefore, we hypothesize that in addition to CHADS2 or CHADS2-VASC score, genetic factor(s) may help identify AF patients with a higher risk of thromboembolic stroke. We propose a three years' project to conduct a genome-wide association study (GWAS) using whole genome sequence (WGS) data to identify these genetic factors. In the first and second years, we plan to consecutively recruit AF patients and perform WGS-based subgroup GWAS to identify new genes or loci related to thromboembolic stroke. In the second and third year, we will establish zebrafish, mouse, cellular and induced pluripotent stem cell (iPSC) models to provide a platform for drug testing and investigate the molecular mechanism by which the identified novel genes contribute to AF-related thromboembolic stroke. Our three-year's project is the first genome-wide WGS SNP study for AF-related thromboembolic stroke and will provide new genetic screen factors to help identify AF patients at risk of thromboembolic stroke and develop novel treatment strategy other than oral anticoagulants.

Endothelial progenitor cell in treatment of cardiovascular disease

內皮前驅幹細胞（EPC）治療心臟血管疾病的進展

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Abstract

The last decade has shown considerable interest in regenerative biology, with particular emphasis on the use of isolated or purified stem and progenitor cells to restore structure and function to damaged organs. Circulating endothelial progenitor cells (EPC) were first discovered in 1997 by Dr. Asahara et al. who identified in the adult human peripheral blood a population of CD34 or kinase insert domain receptor (KDR)-positive cells and have been identified as a potential cell source that contributes to neovascularization via postnatal vasculogenesis. This notion challenged the previous concept that de novo formation of new blood vessels occurs only in the yolk sac mesoderm during embryonic development. Additionally, it is known that the integrity and functional activity of the endothelial monolayer play an essential role in atherogenesis. A series of clinical and basic studies have provided new evidence that the injured endothelial monolayer is regenerated by circulating EPCs. Circulating EPC number has also been reported to inversely correlate with the presence of risk factors of coronary artery disease. A better understanding of the relation between EPCs and atherosclerosis, and how EPC could provide treatment for cardiovascular disease, would provide additional insight into the pathogenesis of cardiovascular diseases and create novel therapeutic strategies.

Cardiac regeneration research using human pluripotent stem cell-derived cardiomyocytes

人類多能性幹細胞衍生的心肌細胞於心臟再生研究的進展

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Electrical impulses from cardiac pacemaker cardiomyocytes initiate cardiac contraction and blood pumping and maintain life. Abnormal electrical impulses bring patients with low heart rates to cardiac arrest. The current therapy is to implant electronic devices to generate backup electricity. Instead, cardiac biological pacing has been developed as a hardware-free alternative. The approaches to generating biological pacing have evolved recently using cell reprogramming technology to create human pacemaker cardiomyocytes in-vivo or in-vitro. The reprogramming-based biological pacing recapitulates various phenotypes of de novo pacemaker cardiomyocytes and is more physiological, efficient, and easy for clinical implementation.

Development and validation of echocardiography-based machine-learning models to predict mortality

運用心臟超音波的機器學習模型預測死亡率

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Echocardiography remains a useful tool to evaluate heart function in patients with cardiac anomaly, especially for HF. Prior studies showed that cardiac systolic function evaluated by echocardiography is a strong prognosticator for HFrEF. However, burden of cardiac functional evaluation and potential bias by manual assessment remains limited. Echocardiography (echo) based machine learning (ML) models may be useful in identifying patients at high-risk of all-cause mortality. Herein, we introduced the clinical application and development of AI in echocardiography for automatic assessment of cardiac functions of HF irrespective clinical phenotypes. Additionally, ML models (ResNet deep learning using echo videos and CatBoost gradient boosting using echo measurements) was used to predict 1-year, 3-year, and 5-year mortality among HF patients from multi-center dataset. Models were trained on the Mackay dataset, Taiwan (6083 echos, 3626 patients) and validated in the Alberta HEART dataset, Canada (997 echos, 595 patients). We examined the performance of the models overall, and in subgroups (healthy controls, at risk of heart failure (HF), HF with reduced ejection fraction (HFrEF) and HF with preserved ejection fraction (HFpEF)). We compared the models' performance to the MAGGIC risk score, and examined the correlation between the models' predicted probability of all-cause mortality. The ResNet and CatBoost models achieved area under the receiveroperating curve (AUROC) between 85% and 92% in internal validation. In external validation, the AUROCs for the ResNet (82%, 82%, and 78%) were significantly better than CatBoost (78%, 73%, and 75%), for 1-, 3- and 5-year mortality prediction respectively, with better or comparable performance to the MAGGIC score. ResNet models predicted higher probability of death in the HFpEF and HFrEF (30%–50%) subgroups than in controls and at risk patients (5%–20%). We concluded that Echo-based ML models are practical and useful to predict mortality showed good internal and external validity and were generalizable and are comparable to an established HF risk score. These models can be leveraged for automated risk stratification at point-of-care (POC) as perspectives.

Disclosure

(Funding)

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Application of AI in cardiovascular disease

應用人工智慧深度學習於心血管疾病與個體化差異關聯性研究

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Background: How to identify high-risk population for next-generation drug-eluting stent (DES) with instent restenosis (ISR) by genetic studies has not been investigated. We thus aimed to study the power of genetic risk score to identify high-risk population for next-generation DES with ISR.

Methods and Results: We enrolled coronary artery disease patients receiving next-generation DESs from January 2010 to December 2019 in our hospital. The participants were classified into the derivation cohort and validation cohort to determine genetic risk score of next-generation DES with ISR. The genetic risk score was defined as the sum of the number of selected exonic single nucleotide polymorphisms (SNPs) for the risk allele. There were 2,749 patients receiving next-generation DESs and 205 patients having DES with ISR confirmed by coronary angiography. Six hundred thirty patients (age: 64.4 ± 10.1 years, male: 80%) were included for genotyping analysis: 72 patients had DES with ISR. After propensity score matching, there were 343 patients and 153 patients in the derivation and validation cohorts, respectively. Five selected SNPs, i.e., SNPs in *CAMLG, GALNT2, C11orf84, THOC5, and SAMD11*, were included to calculate the genetic risk score for next-generation DES with ISR. In the derivation cohort, patients with a score ³3 had significantly higher DES with ISR rates (hazard ratio [HR]: 5.17, 95% confidence interval [CI]: 2.57–10.38, $p < 0.001$). In the validation cohort, the prevalence of DES with ISR in patients with a score ³3 was also significantly higher than that in patients with a score <3 (HR: 3.68, 95% CI: 1.37–9.86, $p < 0.001$).

Conclusion: We demonstrated the significant association between the five SNPs-derived genetic risk score and DES with ISR. This model could provide incremental biological information for interventional cardiologists prior to percutaneous coronary intervention.