

(09)

智慧明醫：創新、精準、高效、友善

Digital Health for Future Medicine: Innovation, precision, efficacy, friendliness

時間：111 年 7 月 16 日(星期六) 08:00~17:30

地點：臺北榮民總醫院 介壽堂

主辦單位：臺北榮民總醫院、中華醫學會

合辦單位：國立陽明交通大學

協辦單位：臺中榮民總醫院、高雄榮民總醫院

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科技部前瞻司「回應國家重要挑戰人工智慧專案計畫」

科技部生科司「應用生醫資料庫開發新穎生物標記及疾病風險評估模式」計畫

臺北榮總放射線部

報名 <https://ppt.cc/fCoUvx> 或掃描



08:20-08:25 Opening Remarks

陳威明教授/院長
Wei-Ming Chen

Session 1：智慧精準醫療的未來趨勢

座長：林奇宏 校長、許惠恒 教授

08:25-08:45 元宇宙的智慧醫療
Smart Medicine in the Metaverse

張嘉淵博士
Ted Chang

08:45-09:05 Precision medicine: An opportunity for digital health

石瑜教授
Yu Shyr

09:05-09:20 臺北榮民總醫院醫療人工智慧發展現況
The Current Status of Medical Artificial Intelligence
Development of Taipei-Veterans General Hospital

高壽延副院長
Shou-Yen Kao

Session 2：新世代醫療的發展與挑戰

座長：侯明志 副院長、唐高駿 院長

09:20-09:40 The state of digital health adoption and what is to come

Prof. Joseph C. Kvedar
(NPJ Digital Medicine
Editor in Chief, Harvard
Medical School)

09:40-10:00 Digital Health Product Development and Implementation

Prof. Bryant Lin &
Prof. Kevin Chang
(Stanford University)

10:00-10:20	Artificial Intelligence for Dementia Screening : An Innovative Approach with ScreenMat	Associate Professor Kelvin Tsoi (Chinese Medical University, Hong Kong)
10:20-10:30	Panel Discussion (Session 1 & 2)	All moderators and speakers
10:30-10:45	<i>Coffee Break</i>	
	Session 3 : 智慧明醫的發展應用 1 座長：陳適安 院長、殷偉賢 副院長	
10:45-10:57	建構智慧社區醫院：生醫科技策略的優質照護 Constructing a Smart Community Hospital: A BioICT Approach for Better Care	陳亮恭教授 Liang-Kung Chen
10:57-11:09	即時血液透析人工智能預判系統平台-運籌毫秒，決勝千里 Real-time Artificial Intelligence-based Hemodialysis Prediction System	唐德成教授 Der-Cherng Tarnng
11:09-11:21	健康零醫院 數位鄰醫院 Double SMART homespital	尹彙文主任 Huey-Wen Yien
11:21-11:33	AI+HI 互動智慧重症診療輔助決策系統 AI+HI Interactive Critical Care with Machine-learning Based Clinical Decision Supportive System	吳杰亮副院長 Chieh-Liang Wu
11:33-11:45	開發新穎次世代基因定序即時分析診斷平台 Development of a novel Real-time analysis and disease diagnosis platform based next-generation gene sequencing	牛道明教授 Dau-Ming Niu
11:45-11:55	Panel Discussion	All moderators and speakers
11:55-12:00	Closing of the morning section	
12:20-12:50	<i>Lunchtime Symposium</i>	飛利浦台灣分公司
13:00-13:05	<i>Opening of afternoon section</i> 下午開場介紹	
	Session 4 : 智慧明醫的發展應用 2 座長：林永煬 副院長、楊智傑 教授	
13:05-13:20	推動病患照護創新應用的次世代智慧醫療資訊服務平台 Revolutionize Patient Care via Next Generation Health Information System	黃泰一博士 Tai-Yi Huang
13:20-13:35	智慧醫院管理 Smart Hospital Management	李偉強副院長 Wui-Chiang Lee
13:35-13:47	研發以合成影像促進醫學影像之聯邦學習 On Synthetic Images for Federated Learning of Medical Images	盧鴻興教授 Horng-Shing Lu

13:47-13:59	醫療人工智慧物聯網創新應用 Innovation Application of Medical AIOT in Clinical Practice	楊智傑教授 Albert C. Yang
Session 5 : 智慧明醫的發展應用 3 座長：馬旭 副院長、曾令民 主任		
13:59-14:11	臺北榮民總醫院癌症資訊系統－癌症部位特意因子 Taipei VGH Cancer Information System - Site-Specific Factors	蕭正英副主任 Cheng-Ying Shiau
14:11-14:23	資通訊科技於外科醫療的實務應用：以臺北榮總為例 Application of Information Technology in Surgical Services: Patients' Journey in Taipei Veterans General Hospital	曾令民主任 Ling-Ming Tseng
14:23-14:35	精準醫學世代之人工智慧數位病理 Digital Pathology with AI in the Era of Precision Medicine	周德盈教授 Teh-Ying Chou
14:35-14:47	應用 P4 醫療模式進行心血管老化個案之高風險特徵的預測及處理 Implementation of P4 Medicine Models in the Identification and Management of High-risk Features for Subjects with Cardiovascular Aging	鄭浩民教授 Hao-Min Cheng
14:47-14:57	Panel Discussion (Session 4&5)	All moderators and speakers
14:57-15:12	<i>Coffee Break</i>	
Session 6 : 智慧明醫的發展應用 4 座長：邱宏仁 主任、徐建業 教授		
15:12-15:24	人工智慧及智慧裝置在急性心肌梗塞的應用：由醫院到救護車 Application of Artificial Intelligence and AIoT in Acute Myocardial infarction: From Hospital to Ambulance	許凱程主任 Kai-Cheng Hsu
15:24-15:36	使用機器學習方法分析頸部血管超音波來診斷腦動脈狹窄 Diagnosis of Intracranial Arterial Stenosis by Using Automatic Analysis of Neck Vascular Ultrasonography Based on Machine Learning Approaches	紀乃方醫師 Nai-Fang Chi
15:36-15:48	情緒精準醫療：預測腦神經刺激術抗鬱療效及頑固型憂鬱症 Prediction of Antidepressant Responses to rTMS and Treatment-Resistant Depression: Results from Precision Depression Intervention Center (PreDIC)	李正達教授 Cheng-Ta Li
15:48-16:00	如何將影像 AI 嵌入與融入臨床工作流程 How to embed and integrate imaging AI into the clinical workflow	孫英洲副主任 Ying-Chou Sun

Session 7 : 智慧明醫的發展應用 5

座長：郭萬祐 教授、連中岳 教授

16:00-16:12	醫療數位轉型：智抗菌平台 Digital Transformation in Healthcare: iAMS	游家鑫主任 Jia-Xin Yu
16:12-16:24	巨量資料在醫學影像人工智慧的研發 Medical Imaging AI: Mega Data Building Up and Beyond	郭萬祐教授 Wan-Yuo Guo
16:24-16:36	智慧互動式醫療運用於心血管疾病之照護 AI and Interactive Medical Care in Cardiovascular Disease	張世霖教授 Shih-Lin Chang
16:36-16:48	A Double Espresso for 三大思維談智慧醫療的設計與實踐 An Ergonomic Double Espresso for Dipping Triple Thinking Into Smart Medicine Design and Development	楊宗龍主任 Tseng-Lung Yang
16:48-17:00	人工智慧在脊椎領域之運用 Application of Artificial Intelligence in Spine Fields	周伯鑫醫師 Po-Hsin Chou
17:00-17:10	Panel Discussion (Session 6&7)	All moderators and speakers
17:10-17:15	<i>Closing Remarks</i>	

Smart medicine in the Metaverse

元宇宙的智慧醫療

Ted Chang

張嘉淵

CTO, Quanta Computer Inc.

廣達電腦

The recent rapid rise of Metaverse creates new possibilities of future smart medicine in the virtual space. Most of the interest now focus on visualization and related applications of Extended Reality (XR) including AR, VR and MR for immersive social experience. In the talk, we shall focus more on the core operation of Metaverse, including digitalization, simulation and virtualization, together with its linkage to real world medical applications through Digital Twins. To support the smart medicine in the new Metaverse, we shall also share our perspectives on the integration of Medical IoT(MIoT), Cloud Computing, Medical Big Data, Machine Learning and AI to build the Digital Twins of various medical and healthcare activities for different users and use cases involved.

The current status of medical artificial intelligence development of Taipei Veterans General Hospital

臺北榮民總醫院醫療人工智慧發展現況

Shou-Yan Kao

高壽延

Vice-superintendent, Taipei Veterans General Hospital, Taipei, Taiwan, ROC

臺北榮民總醫院 院本部

This talk will share with you the current status of medical artificial intelligence development in Taipei-Veterans General Hospital(VGH). The development of medical AI in Taipei-VGH is based on the medical AI development center and AI committee in the hospital to promote all research projects and functional organization from the roots of basic infrastructure, multiple service platforms to various innovative applications which are supported by all specialty departments or centers in the hospital. In the beginning, the AI development was primarily sponsored by the funding of governmental projects, then extended to our own institute and industry cooperation year by year. Very good outward connection has been established with National Yang Ming Chiao Tung University (NYCU), the Academia Sinica and many other institutes. While AI is the tool of God and the precision medicine is the goal of development, lots of productions from projects has been successfully developed in many specialty departments on the roadmap of AI development in Taipei-VGH. I would illustrate some of them in this talk and optimistically look forward to seeing more in the future. On the other hand, we highlight the importance of establishing a nation-wide consortium to include hospitals, research institutes and industry to promote the medical AI development in Taiwan. It is very important to have wonderful industry cooperation to promote any novel idea to project, project to proto-type of product for verification and clinical use. Therefore, the concept of the software as medical device named “SaMD” is proposed to define the AI related medical tool or applications. The future development of medical AI in the hospital or even the whole health care system should account for huge investment on the talented AI manpower, cross-fields cooperation, and funding support from both government and industry.

Artificial intelligence for dementia screening: An innovative approach with ScreenMat

應用人工智慧用於失智症之篩檢：使用 ScreenMat 之創新方法

Kelvin KF Tsoi

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Drawing, such as a pair of interlocking pentagons, is a useful measurement to evaluate the visuospatial functions of people with dementia. With the advancement of technology, drawing behaviour can be real-time captured with digital platforms. We proposed digital analytics on a simple drawing platform and hypothesized that this platform can be used for preliminary screening for dementia. This digital screening platform was designed on a portal tablet and named “ScreenMat”. Patients with Alzheimer’s disease (AD) and Montreal Cognitive Assessment (MoCA) score below 22 were recruited from the Geriatric Research Clinic, and subjects without AD and with MoCA score of at least 22 were recruited from the Osteoporosis Research Centre. An automated scoring platform for interlocking pentagons was developed. All drawing behaviour was digitalized, such as the time of drawing for each line, and hesitation moments between the drawing lines. Some features of the drawing image were automatically identified, such as overlapped and closure pentagons. All time and image features between AD and control were compared by T-test or Chi-square test. A multivariate logistic regression model was fitted for the predictors of AD. Analytics of the digital behaviour of simple drawing is an effective method for dementia screening. Further investigation with machine learning techniques may increase data interpretability and potentially enhance the diagnostic accuracy for dementia screening.

Constructing a smart community hospital: A BioICT approach for better care

建構智慧社區醫院：生醫科技策略的優質照護

Liang-Kung Chen

陳亮恭

Taipei Municipal Gan-Dau Hospital (Managed by Taipei Veterans General Hospital), Taipei, Taiwan, ROC; Center for Healthy Longevity and Aging Sciences, National Yang Ming Chiao Tung University, Taipei, Taiwan, ROC
臺北市立關渡醫院（北榮經營）及 國立陽明交通大學 健康長壽與老化科學研究中心

Utilization of smart technology in the health care services enables the new potentials to improve quality and efficiency of health care services. The smart technology in health care services not only reduces the workloads of healthcare professionals, but also creates new service model and quality assurance programs. Taipei Municipal Gan-Dau Hospital as a community hospital aims to provide comprehensive and community-based health services across primary, secondary and tertiary prevention, and to empower healthy longevity for community inhabitants.

To achieve the goals, we first clearly define goals for the hospital, which is “Promoting Next-Generation Livable Community with Healthy Longevity”. With this goal, we specified four dimensions for action plans, including “cloud-based smart hospital”, “healthy aging communities”, “virtual smart hospital”, and “virtual healthy aging communities”. All dimensions are connected by person-centered data flows via the cloud-based SaaS platform.

In the hospital, integrated health services to promote healthy aging were developed and implemented, including integrated outpatient services, post-acute care services, person-centered functional re-ablement programs, and community-based health promotion intervention programs. Moreover, the hospital administration and management were shifted to web-based real-time monitoring, and all wards and nursing homes were equipped with smart mattress to detect risk of accidental falls and patient positioning, as well as facial recognition system to identify early mood changes, cognitive declines and neuropsychiatric symptoms of dementia. Besides, all employees were included in a smart insurance policy to encourage engagement in health promotion activities. In particular, the hospital is re-designing a cloud-based HIS and NIS system that connects all health data of individuals to improve their health services.

Overall, the BioICT approach aims to improve the quality and efficiency of care to promote healthy longevity for all community inhabitants, which requires much more than simply devices and algorithms. Like all previously developed biomedical innovations, the most impactful achievement is the quality of disease diagnosis, treatment and prognosis. Hence, the BioICT approach should also aim the same goals with novel data collection, modeling and interpretation to change the models of health care services.

Real-time artificial intelligence-based hemodialysis prediction system

即時血液透析人工智能預判系統平台 - 運籌毫秒，決勝千里

Der-Cherng Tarng

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The prevalence of dialysis in Taiwan is the highest all over the world. There are more than 90,000 patients undergoing dialysis, and more than half of the dialysis patients died of cardiovascular disease and heart failure. In our institution, we initiated the first phase artificial intelligence (AI) project to instantly predict the risk of heart failure and pulmonary edema, as well as the adequate dry weight of our hemodialysis patients. We teamed up to develop AI risk prediction model for hemodialysis patients and cooperate with the worldwide top data analysis manufacturers. We used the research database from the big data center of Taipei Veterans General Hospital (TPE-VGH) and 200 parameters changed produced by the kidney dialysis machine every millisecond to train the AI system for predicting the risk of heart failure. The accuracy of risk prediction rate is 90% for heart failure. We further found out the most critical key factors for the risk of heart failure judged by hundreds of parameters, and the accuracy of risk prediction rate is 95% for heart failure. These data were presented on the dashboard as the reference to the medical staffs. In addition, our team also used the AI system to train the dry weight prediction, and we successfully reduced the error value of the dry weight from 400 grams to 40 grams, and the error value was reduced by 80%. In the future, we will expand the development system, including conducting the clinical trials in our hospital and applying for the Taiwan Food and Drug Administration (TFDA) Software as a Medical Device (SaMD). We will promote this SaMD to the dialysis centers or facilities to reduce the burden of medical staffs, and to improve the outcomes and increase the safety to the hemodialysis patients.

Double SMART homespital

健康零醫院 數位鄰醫院

Huey-Wen Yien

尹彙文

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In the era of digital transformation, smart care should cover the whole patient journey between home and hospital. **Homespital** is a term to represent the scenario of “hospital without wall”, including critical and concierge care.

As we know that if we just implement the smart devices without de-implementing the low-value patient care process, there will be another disaster to clinical staffs. There are **double SMART** core elements for clinical innovation, including both physical “Service, Management, Architecture, Research, Technology” and digital “Save, Mobile, AI, Robotics, Telecare”.

Medical directors are the key drivers of digital transformation in clinical care. They are in a prime position to facilitate change and improve physician alignment with systemwide goals. We are designing the paradigm shift models for the young digital generation to facilitate the transformation of clinical care by their own way.

Telecare is surely one of the solutions for the current pain points in medical ecosystem for the next decade. First example, in Mercy Virtue hospital, the world’s first facility dedicated to telehealth, they propose the “**Hospital without beds**” project. Dr. can “see” patients where they are. They are the Virtue Intelligent Physicians(VIP) in the era of Digital Medicine(DM).

Another example is the “Journey with Guided Care” in Cleveland Clinic Medical Center showing their great core value, “Every patient deserves world-class care.”

In conclusion, we are facing the great challenges in our care of patient journey including overloading, shortage of workforce, burnout of professional providers and finally collapse of the entire medical care system. The new model of **double SMART homespital** will be the possible trend in the next decade.

AI+HI interactive critical care with machine-learning based clinical decision supportive system

AI+HI 互動智慧重症診療輔助決策系統

Chieh-Liang Wu

吳杰亮

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Intensive Care units (ICUs) are equipped with many monitoring systems to provide comprehensive and continuous intensive care. Despite the increasing application of artificial intelligence (AI) technology in many fields, the practical application of AI in the medical field remains limited. To employ AI in critical care for improved quality and efficiency of critical care medicine, we have established a multidisciplinary team consisting of intensivist and information technology engineers at Taichung Veterans General Hospital (TCVGH), AI Center at Tunghai University, an information system engineer at ADVANTECH. Using the big data of ICUs, we create a machine-learning-based clinical decision system for respiratory, renal, bacteremia, and mortality risk. Those models are integrated into the AI+HI interactive critical care dashboard, which provides real-time inferences and guideline-based clinical recommendations. We wish the system would improve patient safety and quality and unload the burden on clinical staff.

Revolutionize patient care via next generation health information system

推動病患照護創新應用的次世代智慧醫療資訊服務平台

Tai-Yi Huang

黃泰一

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Along with medical regulation relaxation and technology breakthrough, most hospitals in Taiwan have been caught in a dilemma of renovating Health Information System (HIS), which in general is considered legacy because of the system complexity, data limitation, and information silo. Current HIS in use is usually composed of various subsystems of clinical, administrative, and financial managements. Since the subsystems are possibly developed in different programming languages, among which some are outdated and rarely used, the burden of integration and operations has been increased. Moreover, the data schema of HIS is originally designed for health insurance declaration. To retain more information on patient's care, data columns should be expanded, and systems require upgrades. This process can be done only if HIS is shut down temporarily. In addition to the potential cost, extra efforts are needed when integrating and utilizing data among subsystems because of the inconsistency of the data models, let alone data integration among hospitals.

ASUS Next Generation Health Information System (xHIS) is a powerful AI-embedded platform that aims to give healthcare providers a modularized, hybrid cloud-based, and FHIR-enabled information service. Modularized architecture with microservices equips xHIS with smooth development and easy operation since each microservice is independently deployed and extended, causing rare influences to the others. Cloud-based platform enables compatibility, extensivity and portability. Existing HIS systems can be integrated less painfully to xHIS, which allows IT to develop patient-centric services effectively to enhance the healthcare quality. With web-based applications, each service is accessible any time, any where, and any device. Furthermore, FHIR-based data model accords with international standard, licensing interoperability among hospitals locally or internationally.

As a platform, xHIS favors internal groups to develop applications to given purposes, as well as third-party developers to launch new proprietary services. This breakthrough of medical technology will bring more momentum to this industry and complete the ecosystem.

Smart hospital management

智慧醫院管理

Wui-Chiang Lee

李偉強

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臺北榮民總醫院 院本部

The Taipei Veterans General Hospital (TVGH) serves around 10,000 outpatient and 3,000 inpatient patients by 8,000 employees every day. For providing high-quality, safe, effective, efficient, and patient-centered care, TVGH has continuously streamlined and digitalized its administrative processes over the past three decades.

Patients can find doctors for specific discomforts using keyword searches on the hospital website and make appointments using APPs on smartphones. Less than 10% of all outpatients need to queue for appointments. There are interactive kiosks providing tour guides for the outpatient environment in different languages. Patients can also pay the bills either using automatic transfer machines on every floor or APPs. Electronic medical records have covered nearly 98% of all previously paper-based records. The fully paperless goal is to be achieved before the end of 2022. Clinical doctors can access patients' laboratory, imaging, and pathology studies result over the past 10 years online at the point of care. AI-assisted outpatients have been established for several diseases since 2019. During the COVID-19 pandemic in 2021, telemedicine and remote consultation were provided for 8,000 patients with chronic illnesses and the quarantined at home. Patients or their families paid the bills through APPs.

All inpatient services are fully supported by advanced information and communication technologies. The brand-new operation system empowers medical staff to access patients' information stored at different locations timely. The widely deployed Wi-Fi system at every ward enables medical staff to explain clinical reports to patients at the bedside. To make the inpatient services efficiently utilized, the length of stay, occupancy rate, and many other parameters are automatically collected and analyzed as a reference for real-time patient flow management. Patients can make a discharge procedure and pay the bill at nursing stations. A smart hospital steering committee has been established in 2018 to organize administrative and clinical departments toward more advanced and patient-centered efforts in management, medical care, research, and clinical training.

On synthetic images for federated learning of medical images

研發以合成影像促進醫學影像之聯邦學習

Tsung-Hung Tsai, Henry Horng-Shing Lu

蔡宗紘 盧鴻興

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Federated Learning (FL) provides the feasible approach to jointly train the machine learning model without accessing private data in various medical institutions. However, the resulting FL model could be biased towards institutions with larger training datasets. Institutions with a relatively limited amount or heterogeneous types of data may have lower accuracy. In this study, we propose the framework of Synthetic Images for Federated Learning (SIFL) that integrates the information of local institutions with heterogeneous types of data. The main concept of the SIFL is to develop the resulting global model that can handle the diversity in heterogeneous types of data collected in local medical institutions by synthetic images similar to minor types in local collections. We use the chest X-ray images of COVID-19 and the color fundus images of glaucoma to compare the results from the centralized learning and several decentralized learning frameworks. The result demonstrates that SIFL-based models outperform the conventional FL models. For institutions with the relatively limited amount of heterogeneous types of data, the model performance of SIFL is improved in these empirical studies.

Innovation application of medical AIOT in clinical practice

醫療人工智慧物聯網創新應用

Albert C. Yang

楊智傑

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The most important revolutionary breakthrough in modern industry is automation technology. The development of Internet of Things (IOT), cloud computing, 5G, artificial intelligence (AI), and blockchain has contributed to the development of industrial Implementation of automation. At present, one of the important areas in the development of the new industrial era is the research and development and implementation of smart healthcare. How to use information technology to provide affordable, efficient, safe and reliable health care services is an important challenge for the development of smart healthcare in the next decade.

Smart healthcare can use technologies in different fields. In addition to making the operation of the medical system more intelligent, it can also combine advanced networks to integrate patient data and promote the development of telemedicine. At the same time, combined with big data and AI and other information and communication technologies, we have developed technologies that use AI technology to medical wearable devices that can record personal health conditions at any time, helping doctors to quickly and accurately evaluate physiological conditions of patients. On the whole, it can not only reduce the burden of medical staff, but also improve the efficiency and quality of medical services.

These innovative applications are three-folds; each focuses on a specific area of medical care, including health monitoring, remote care, and acute care. For health monitoring, we have developed an AI-based home sleep monitoring platform that can differentiate patients from insomnia with obstructive sleep apnea (OSA), and used medical wearable device of saturation monitor to evaluate the severity of OSA, as well as heart rate monitor to evaluate sleep stages based on AI algorithms.

Next, for the remote care, we developed a remote solution for automatically monitoring patient's saturation and heart rate in the quarantine setting. With the aid of AI algorithm, the platform can notify the patient and nursing staff when the patient has deterioration in physiological conditions, such as silent hypoxia. We have implemented these services during the COVID-19 outbreak in Taiwan.

Finally, we developed a sepsis warning system for acute care. The system involved wearable devices that can measure blood pressure, heart rate, saturation, respiratory rate, and body temperature. Using this vital signs data, our AI algorithm can achieve high accuracy of prediction of onset of sepsis in the earlier time, allowing the management of those patients with risk of sepsis in the timely manner.

Taipei VGH cancer information system: Site-specific factors

臺北榮民總醫院癌症資訊系統：癌症部位特意因子

Cheng-Ying Shiau

蕭正英

Division of Radiation Oncology, Department of Information Management, Taipei Veterans General Hospital, Taipei, Taiwan, ROC

臺北榮民總醫院 放射腫瘤科，資訊室

The central hub of Taipei VGH Cancer Information System (CIS) is Cancer List module, which was created to meet the challenge of the very first accreditation of cancer care program in 2008. With the funding from “Establishment of a Cancer Research Excellence System Program” of MOHW, Taipei VGH started the lengthy 6-year software development process of CIS from April 2010.

Applying service-oriented architecture and parameterized program control, Taipei VGH has successfully implemented an expandable, comprehensive, research oriented and clinical workflow-compliant CIS, supporting both common requirements of all cancers and specific needs of individual cancers. CIS, centered on patient's cancer diagnosis, is seamlessly integrated into hospital information system with the following modules: cancer list/diagnosis, cancer stage and site-specific factors (SSF) database, pretreatment work-ups, comorbidity and history, cancer treatment plan (CTP), multi-disciplinary team (MDT) case conference, peer-auditing quality control, adverse event logging, patient follow-up status and failure pattern report, cancer registration, case management, cancer care consultation fee reimbursement claiming, and visualizing analysis.

One of the many good features of CIS that are not implemented in peer institutes is expandable SSF with strict data standards. The MDT could update and add new SSF without limitation. A new SSF data item could be used for a specific cancer in about 5 minutes of setting reference table without the need of changing the programming code.

For cancer research, the parameters/variables could be obtained from cancer list/diagnosis, cancer stage and SSF database, treatment/intervention in CTP, while the end points from patient follow-up status, failure pattern and adverse event.

This talk focuses on the SSF with the following topics: (1) The origin of the SSF. (2) SSF of Taiwan Cancer Database/Cancer Registry. (3) SSDI of National Cancer Database. (4) The implementation of SSF in Taipei VGH: Classification and Composite SSF. (5) Source data of SSF.

Application of information technology in surgical services: Patients' journey in Taipei Veterans General Hospital

資通訊科技於外科醫療的實務應用：以臺北榮總為例

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In the era of artificial intelligence, the tradition of surgical service is challenged, including the burden of data integration, patient care delivery and digitized operation system. These patient-centered topics on the surgical journey need to be redefined by remodeling the data infrastructure, experts in data processing as well as analyzing, deep inspection of user experiences. To achieve this goal, the surgeons, nurses, and information technicians in Taipei Veterans General Hospital has transformed the data flow of the surgical patients' journey via a series of IT system development and continuous formation of an eco-system of IT innovation for all the employees in our hospital to join the revolution.

At the very beginning in out-patient clinic, the IT system recognizes those of first visits and raise the awareness to clinicians by triaging the disease status within a page of questionnaire offered via App or webpage. The collected information is further integrated into the medical chart at clinics. A serial of exams is then arranged after coordinating the schedules of different departments to facilitate the process without prolonged waiting time. All the schedules are listed on the calendar provided in the App developed by department of Surgery with multi-factor authentication and entity verification to ensure the privacy of personal health data. At the meantime, all the information in relation to the choices of treatment including the advantages and risks of surgery as well as the resources of shared-decision-making (SDM) are pushed to the patients' mobile device according to the ICD-10 codes or operation schedules documented and retrieved from the backend of the electric medical records. At this point, couple of AI models has been developed to improve the process of decision making, including the Patients-similarity-based Colorectal Cancer Outcome Visualization Platform, and I-SWAT non-invasive skin wound diagnostic tool provide by Plastics. Hence the concept of digital twin in hospital is shaping.

When it comes to the surgery, pre-operative discussion with 3-dimensional reconstruction of CT images is applied in living donor liver transplantation to ensure the safety of the healthy donor without compromising the successful rate of the surgery. Besides, vital signs data, operative video and sounds as well as radiographic images are synchronized during surgery to provide full-dimensional information to the surgeons. For all the surgical patients, more than 15 real-time checkpoints are recorded to monitor the process for clinicians and console the families timely. The critical time points are also structurally documented for surgical notes and raising alarms after machine learning. After the surgery, the patient can be discharged earlier to comfortable environment with confidence since our App can help the patients to report their conditions, such as side effects, unexpected changes of wound and drains without delay. All of

these services are maintained by the surgical case management system. By close monitor and computerized analysis of electric health data retrieved from patients outside of hospital, we continuously proceed to the Utopia of Homespital.

The achievements can not be accomplished by the clinicians only. IT companies and scientists with domain know how of medical are the key factors. With standardized API and data format, there are endless chances of applying information technologies to the surgical field. We look forward to cooperate with all sort of resources to create a tempered, warmth environment on the surgical patients' journey.

Digital pathology with AI in the era of precision medicine

精準醫學世代之人工智慧數位病理

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Digital Pathology has revolutionized the practice of pathology and the efficiency and efficacy of clinical diagnostics. The current practice of pathology based on eyeball observation under the microscope has evolved into interpreting photogenic details on computer screens. In addition to the “subjective” morphologic data analyses facilitated by special stains and immunohistochemistry, currently, testing with genetic and cytogenetic methodologies have been vigorously used in this era of precision medicine. Along with the development of next generation sequencing for genomic studies, management of the “big data” has become the seminal factors influencing the treatment and management of patients with all different diseases, either neoplastic or non-neoplastic. With the rapidly increased application of artificial intelligence (AI) to medical imaging, the essence of AI has become more and more seminal in the routine clinical practice, on top of the contribution by digital pathology. We have to face this trend and well prepare ourselves to battle with the digital images with the help from AI, the final common ways of scientific affairs in the very near future.

Development of a novel real-time analysis and disease diagnosis platform based next-generation gene sequencing

開發新穎次世代基因定序即時分析診斷平台

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Next generation sequencing (NGS) is one of the most important tools for the development of precision medicine. It has greatly improved the ability of sequencing and has become an important tool in disease diagnosis and medication. Through the popularization and maturity of this technology, the cost of sequencing has been greatly reduced and the output of information has become faster and faster. Meanwhile, the efficiency of analyzing huge genome sequence data in the back-end had become more and more important. Our center cooperates with a current bioinformatics service company to jointly develop a rapid diagnosis platform for whole-exon sequencing and whole-genome sequencing. For whole-exon sequencing, the analysis results can be obtained for less than 5 minutes. The platform has a concise, user friendly and easily understand interface. This allows us to quickly upload the whole gene sequencing data and analyze according to the doctor's needs in real time. The platform provides accurate analysis results in a short time and assists clinicians in the diagnosis of diseases. Through the development of the real-time analysis system, patients with rare genetic diseases will be able to obtain rapid diagnosis and early treatment. Moreover, if other disease-causing gene mutations were found during the analysis process, personal prevention/medical plans can be formulated for each individual's situation. Furthermore, through pharmacogenomics analysis, a more accurate and safe medication guide is tailored for each person. We hope this system can make the analysis of WES/WGS more accessible and useable for general physician and then it could promote the development of precision medicine in Taiwan.

Application of artificial intelligence and AIoT in acute myocardial infarction: From hospital to ambulance

人工智慧及智慧裝置在急性心肌梗塞的應用：由醫院到救護車

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It is widely known that rapid reperfusion is essential to successful ST-segment elevation myocardial infarction (STEMI) treatment. Door-to-balloon time (D2B) is a standard metric of the quality of STEMI treatment. To shorten the D2B time, we have developed AI algorithms, including an ASAP score and an automatic ECG classification system.

To identify the patients without typical chest pain symptoms, we designed an ASAP score using the most common symptoms in STEMI patients without chest pain. The ASAP score was used in the triage system in ER. To build an AI algorithm for automatic ECG classification, we used more than 3000 12-leads ECG signals with annotations obtained by consensus of 3 board-certified electrophysiologists as the criterion standard. The system could notify physicians automatically and has been used in the ER of CMUH, Taichung, since July 2020. The accuracy is more than 99%, and the D2B time is shortened significantly.

According to the development of telemedicine, we have collaborated with the AIoT company and developed a platform for ECG transmission. The platform has been used in the remote mountain region and on the ambulances of Taichung and Nantou since June 2021. Several STEMI patients were identified using this platform.

The combination of AI and AIoT can help patients in the hospital and also patients in the community. This system can shorten D2B time, as well as S2B (Symptoms-to-balloon) time. In addition, this algorithm was approved by TFDA Software as a Medical Device (SaMD) in December 2021. This algorithm can be used not only for research but also as a product in other hospitals.

Diagnosis of intracranial arterial stenosis by using automatic analysis of neck vascular ultrasonography based on machine learning approaches

使用機器學習方法分析頸部血管超音波來診斷腦動脈狹窄

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Intracranial arterial stenosis (ICAS) is a unique and significant risk factor of ischemic stroke in East Asian people: ICAS exists in about 15 to 20% aging population. Unfortunately, ICAS is usually asymptomatic and most patients are aware of its existence after it causes stroke. In addition, patients with symptomatic ICAS have 10 to 15% annual stroke recurrence rate, which is much higher than stroke of other etiologies. ICAS can be treated by strictly controlling vascular risk factors. Therefore, it is essential to identify the existence of ICAS before stroke onset.

To identify the existence of ICAS, it is necessary to perform advance neuroimaging such as computed tomography angiography (CTA) or magnetic resonance angiography (MRA) of brain. However, these advanced neuroimaging techniques are not affordable for general population in health examination. Instead, ultrasonography is affordable and has been widely applied in health examination. However, although the ultrasonography is feasible for screening extracranial vascular disease, it has significant limitations in identifying ICAS, including low successful rate of transcranial ultrasonography, and suboptimal diagnostic accuracy of current methodology.

Currently, there are a lot of imaging techniques applying algorithms base on machine learning approaches to increase the diagnostic sensitivity and accuracy. One approach is to use support vector machine (SVM) to build a diagnostic model using the waveform features of extracranial cerebral arteries to classify the patients with and without ICAS. This method has many advantages: It uses extracranial vascular ultrasonography so it does not have the problem of low successful rate of transcranial ultrasonography, it does not need ultrasonography operators to modify their practice habits; and it can provide acceptable diagnostic sensitivity and accuracy of ICAS

The current speech is to share the experience of developing ICAS diagnostic techniques based on extracranial vascular ultrasonography and machine learning approach in the Taipei Veterans General Hospital and National Yang Ming Chiao Tung University.

Prediction of antidepressant responses to rTMS and treatment-resistant depression: Results from Precision Depression Intervention Center (PreDIC)

情緒精準醫療：預測腦神經刺激術抗鬱療效及頑固型憂鬱症

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Treatment-resistant depression (TRD) is common in depressed patients and is associated with high disability, high healthcare costs, and high quality of life. Correctly predicting depressed patients with higher refractoriness could remind clinicians of more aggressive treatment and improve clinical outcomes of these patients. In addition, intermittent theta-burst stimulation (iTBS) and 10-Hz repetitive transcranial magnetic stimulation (rTMS) are effective antidepressant interventions for TRD but clinical responses across individuals vary. Therefore, reliable predictors for predicting TRD and for antidepressant response to iTBS or rTMS need further investigation. The advance of artificial intelligence, including different models of machine learning (ML) and deep learning (DL) highly enhances the possibility of reliable prediction in depressed patients with highly clinical heterogeneity. In this talk, I will introduce the AI results of using EEG, resting-state functional MRI and 18F-FDG PET to predict TRD and antidepressant responses to rTMS and iTBS. The selected features from the final model also provide hints about the underlying mechanisms of TRD and antidepressants of different forms of brain stimulation. In addition, I will introduce our recently-established specific treatment center for depression, “Precision Depression Intervention Center (PreDIC)”.

Implementation of P4 medicine models in the identification and management of high-risk features for subjects with cardiovascular aging

應用 P4 醫療模式進行心血管老化個案之高風險特徵的預測及處理

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Heart disease is the second killer among the top ten causes of death in Taiwan. If combined with vascular diseases such as stroke, high blood pressure, diabetes and kidney disease, it has far exceeded the number of lives claimed by cancer. Preventive strategy can help reduce the development and progression of cardiovascular diseases. To effectively control the impact of cardiovascular diseases, medical institutions and many industry and research units are actively developing better prevention, diagnosis, treatment and monitoring strategies. With a deeper understanding of the underlying pathophysiological mechanisms and causes, as well as the advancement of medical and computer technology, medicine is gradually changing from a reactive type to a proactive and preventive type of science. P4 Medicine is a method to make medicine more predictive, preventive, personalized and participatory. Its two main goals are to quantify health and predict and prevent disease. P4 Medicine represents the transformation of medical treatment from a mode of responding to diseases to as much as possible to keep individuals healthy or maintain a stable disease state. In this talk, we will present our results in implementation of the P4 Medicine model. The integration of artificial intelligence modules and novel protein biomarkers will develop into a novel disease prediction model and be applied to the development of personal health and disease prevention, diagnosis, treatment and monitoring strategies.

Digital transformation in healthcare: iAMS

醫療數位轉型：智抗菌平台

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Digital transformation in healthcare is about embracing and employing advanced technologies and innovative approaches to maximize benefits. Antimicrobial resistance (AMR) has been identified as a major problem globally, and overuse and misuse of antibiotics have become the main driving forces increasing AMR threats. Current conventional approaches require 48 hours to detect AMR, there is a need to shorten the duration to reduce mortality rates and the spread of AMR. Matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF MS) has been used commonly in the clinical microbiology laboratory to identify bacteria. As MALDI-TOF provides mass spectra with distinctive signatures, MS data can be used as input to train ML algorithms in predicting AMR. ML has been used to improve biomedical workflow recently. In this study, ML models were developed to predict AMR for 8 different bacterial species from MALDI-TOF raw data. With ML approaches, AMR detection can now be performed in seconds and the whole process is shortened by 24 hours. iAMS combines clinical MALDI-TOF signals and machine learning models to identify drug-resistance bacteria. By comparing the differences in MALDI-TOF MS signals and using the model trained with the clinical big data to classify peak patterns of drug-resistant phenotypes in an hour. iAMS integrates clinical laboratory practice and machine learning technology to accelerate the digital transformation of medicine.

Medical imaging AI: Mega data building up and beyond

巨量資料在醫學影像人工智慧的研發

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Medical application of artificial intelligence (AI) is one of the hottest topics in medical community, nowadays. The application from its initiative to the destination, namely data collection and clean up, algorithm and model development, publication, patent filing, regulatory approval of clinical use and landing, and going to market, is a long journey before it, finally, benefits patients. Along the journey multiple disciplinary and group collaboration are the essence of success. Dataset, from which AI algorithm and model are generated, form the basis for the essence. Dataset to the AI ecosystem is like that of raw petroleum to the industry.

In general, dataset (imaging or non-imaging) are the bigger the better and the more heterogeneous the more powerful. There are basically two major ways, centralized and non-centralized, to build up mega medical imaging dataset when AI modeling is concerned. In hospital dataset is a typical example of centralized one. It is usually homogeneous; however, it takes longer time to become big. On the contrary, non-centralized dataset have the potential to become big by applying federated learning (FL) on the dataset. In the FL setting, all dataset from edge institutes are kept at local (edge) and only the models (initial and intermediate) and their statistics parameters of inference are shared (centralized). Compared with the centralized method, FL keeps the data privacy and integrity. It is also found that the performance of AI model that stems from FL is not inferior to centralized one.

There are multiple pros and cons between the centralized and FL settings in the sense of data collection, model development, software, and hardware demanding (computing and storage capacity) administrative challenges, and real-world application. In the speech, typical examples of the application of centralized and non-centralized/FL in developing imaging AI models will be presented. It is concluded from the initial studies and experience that both methods have the role-playing in model development for assisting clinical diagnosis of brain tumors on MR images. To familiarize the methods and optimize their clinical use in various scenarios, e.g., collaboration among hospitals/hospital series, or international studies is the way of well-using datasets for facilitating AI application in real-world of medical ecosystem.

AI and interactive medical care in cardiovascular disease

智慧互動式醫療運用於心血管疾病之照護

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There are different artificial intelligence (AI) models which constructed by the technique of classical machine learning or deep learning in prediction of atrial fibrillation (AF). Indeed, deep learning model has been applied in image recognition to facilitate the clinical practice. In particular, the deep learning algorithms can be applied to electrocardiograms, capable of identifying abnormal heart rhythms and mechanical dysfunction associated with AF. Deep learning can be used in analyzing the big data of clinical parameters which may provide the prediction of outcome in AF patients.

We collaborated with NCTU to establish the AI models which can predict the outcome in AF ablation. The first AI model address that automatized extraction of left atrium volume from 2-dimensional computed tomography (CT) images using deep learning technique. On the other hand, we know that non-pulmonary vein triggers have been reported as an important predictor of recurrence post AF ablation. The deep learning *approach* was also applied in pre-ablation pulmonary vein CT geometric slices to create prediction models for trigger origin and recurrence after catheter ablation in patients with paroxysmal AF. We also collaborated with Quanta company to develop the remote ECG monitoring using AI algorithm. 14-days ECG monitoring device was tested in our center with high detection rate of arrhythmia. There are some gaps in the public's awareness and understanding of AF. (1) AF comorbidities require integration of care and professional advice to prevent confusion in people. (2) The treatment decisions and orders requires complete comprehension by the nurses, pharmacists, and patients for accurate implementation. (3) AI monitoring for the smart care of AF patients is required. Our solution is to create an intelligent communication platform that can met the needs for the management of 3 domains: Anticoagulation, better symptom control, comorbidity control.

An ergonomic double espresso for dipping triple thinking into smart medicine design and development

A Double Espresso for 三大思維談智慧醫療的設計與實踐

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This short talk aims to focus on the use of triple thinking, including design thinking, critical thinking and replay thinking to harness the triple power of innovation, quality assurance and information technology. The introduction of human factors engineering is essential to bring innovation to the forefront of the life sciences and medical industry with the hope to form the closed loop of effective real world data, real world evidence and real world value with failure mode and effect analysis (FMEA) in mind.

Application of artificial intelligence in spine fields

人工智慧在脊椎領域之運用

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Recent advances in artificial intelligence (AI) and deep learning (DL) have shown great performance in identifying non-medical images, and the technology is thought to be the next technological revolution in the clinical application. Based on the current published papers, three main categories of clinical application by AI and DL in the spine fields are (1) automatic measurement (2) diagnosis in medical images (3) prognosis outcome prediction. Some of these published papers also provide Uniform Resource Location (URL) for open access algorithm in clinical applications.

Regarding our current AI model for vertebral fracture detection in the plain lateral radiographs of spine, the framework of AI deep learning model included object detection, data pre-processing of PLRs, and classification to detect VFs. The accuracy, sensitivity and specificity for the performance of AI model were 91.88%, 90.94% and 92.83%, respectively.

However, false positive and false negative rates were inevitably occurred. The factors of lung markings at thoracolumbar junction, X-ray technique, bean-can effect, normal variance of bi-concave appearance in the osteoporotic vertebral body and osteoporosis plays important roles in bias the performance of AI model. We also investigated that our AI model had higher accurate rate if the vertebral fracture was located at lumbar spine and patient's DXA T score ≤ -2.5 . Fortunately, our novel innovation of the AI model with ensemble method got patent in Taiwan and get the 18th National Innovation Award in the Academic Research Category.

The evidence suggests that AI models can be successfully used for spinal disease to manage its diagnosis, prognosis and outcome prediction. Further AI or DL algorithm retraining, generalizability of models, data standardization in neural networks, and focus on the application of AI or DL models as a tool in clinical spine practice, will augment decision-making efficacy.