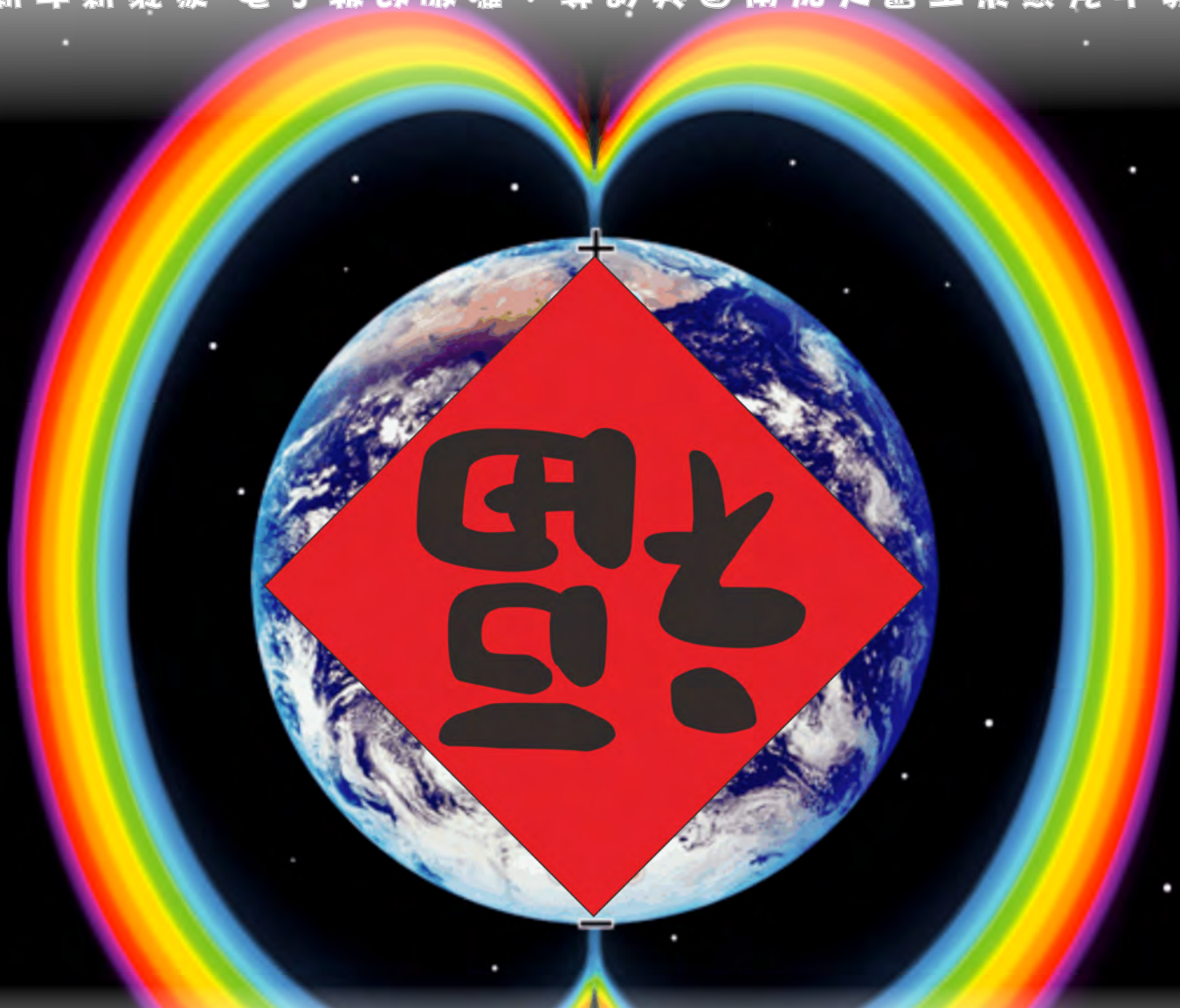# 醫工學會

中華民國生物醫學工程學會

E-Newsletter

Taiwanese Society of Biomedical Engineering

2014新年新希望　健康如意　馬到成功　福至心靈

新年新氣象 電子報改版囉：專訪美國南加大醫工系熊克平教授

醫學會

2014創意競賽將於2014/2/1開放線上報名!!
2014亞太醫工會議結合學會首屆國際醫工會議
10月將於台南國立成功大學舉辦!歡迎參加!!

更多醫工動態盡在醫工學會電子報，請即刻閱讀！學會為了嘉惠醫工大家庭，100年4月回復電子報發行，預計每三個月出刊一期，敬請期待，對於本學會電子報，有任何意見，歡迎來電指教 (06) 2760665

目錄

敬致各位親愛的會員：

　　首先感謝各位會員的踴躍參與學會舉辦的系列活動，在所有理監事、各委員會和學會工作小組的努力之下，學會各項業務得以順利展開，由衷感恩所有付出心力和貢獻的夥伴。未來工作重點包括國家醫工證照持續推動、激勵生物醫學工程創意競賽、加強醫療器材產學合作、國際化提升台灣能見度。

　　2014 中華民國生物醫學工程創意競賽將於 2014 年 2 月 1 日開放網路線上報名，目的為培養我國生物醫學工程相關科系學子，使其具有創意思考與設計之能力，並且具備積極落實理論與實務結合相關領域整合特質。另外，「2014 IFMBE 亞太生物醫學工程會議」將整合於 1st Global Conference on Biomedical Engineering 於 2014 年 10 月 9-12 日於國立成功大學舉辦，希望兩年一次的國際醫學工程會議可以幫台灣加速提升國際能見度，培養下一代年輕學子的國際化能力和視野。

　　學會將積極為台灣醫療器材產業做貢獻，加強醫療器材產學合作乃首要工作重點，本學會將和「台灣醫療暨生技器材工業同業公會」交換代表出席對方理監事會，討論合作議題和策略，使得學術研究和培養之人才可以加速醫療器材研發水準之提升，為未來三、四十年急需的健康照護產業在世界上扮演重要角色，提升台灣經濟成長。

　　值此歲末迎接新的一年的到來之際

恭賀
　　　闔家平安　健康如意

　　　馬到成功　心想事成

　　　　　　　　　　　　　　　　　　　　　　　　弟
　　　　　　　　　　　　　　　　　　　　　　　　蘇芳慶
　　　　　　　　　　　　　　　　　　　　　　　　葉宗仁　鞠躬
　　　　　　　　　　　　　　　　　　　　　　　　王士豪

【理監事會議重要訊息發布】
台灣醫療暨生技器材工業同業公會為加強產學合作及與本會建立密切
關係，經本會理監事會議同意與之交換理監事一席位，本會將推派一
名理監事，代表列席醫材公會理監事聯席會議。且本會生物醫學工程
推展委員會將新增任務，推動後續產學合作事宜。

蘇芳慶 葉宗仁 王士豪 翔鈔

賀年
Happy new year
農曆甲午年・二零一四年

【重要訊息】2014 中華民國生物醫學工程創意競賽將於 2 月 1 日開放網路線上報名：http://proj.ncku.edu.tw/bmeic/index.html， 請各位會員積極鼓勵學子報名。

【重要研討會訊息】

　　2014 IFMBE 亞太生物醫學工程會議將整合 1st Global Conference on Biomedical Engineering 於 2014 年 10 月 9-12 日於國立成功大學舉辦，希望兩年一次的國際醫學工程會議可以幫台灣加速提升國際能見度,培養下一代年輕學子的國際化能力和視野。研討會網站已上線：http://conf.ncku.edu.tw/apcmbe9/index.html，投稿期限為 2014/06/01，歡迎各位會員踴躍投稿參加。

An Interview from an Authoritative Scholar
Dr. K. Kirk Shung

Brief Introduction

Dr. K. Kirk Shung obtained a B.S. degree in electrical engineering from Cheng-Kung University in Taiwan in 1968; an M.S. degree in electrical engineering from the University of Missouri, Columbia, MO, in 1970; and a Ph.D. degree in electrical engineering from the University of Washington, Seattle, WA, in 1975. He taught at The Pennsylvania State University, University Park, PA, for 23 years before moving to the Department of Biomedical Engineering, University of Southern California, Los Angeles, CA, as a professor in 2002. He has been the director of the NIH Resource on Medical Ultrasonic Transducer Technology since 1997.

Dr. Shung is a Life Fellow of IEEE and a fellow of the Acoustical Society of America and the American Institute of Ultrasound in Medicine. He is a founding fellow of the American Institute of Medical and Biological Engineering. He received the IEEE Engineering in Medicine and Biology Society Early Career Award in 1985 and was the coauthor of a paper that received the best paper award for the IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control (UFFC) in 2000. He was elected an outstanding alumnus of Cheng-Kung University in Taiwan in 2001. He was selected as the distinguished lecturer for the IEEE UFFC society for 2002–2003. He received the Holmes Pioneer Award in Basic Science from the American Institute of Ultrasound in Medicine in 2010. He was selected to receive the academic career achievement award from the IEEE Engineering in Medicine and Biology Society in 2011.

Dr. Shung has published more than 400 papers and book chapters. He is the author of the textbook Principles of Medical Imaging, published by Academic Press in 1992 and the textbook Diagnostic Ultrasound: Imaging and Blood Flow Measurements, published by CRC Press in 2005. He co-edited the book Ultrasonic Scattering by Biological Tissues, published by CRC Press in 1993. Dr. Shung's research interests are in ultrasonic transducers, high-frequency ultrasonic imaging, ultrasound microbeams, and ultrasonic scattering in tissues.

Prof. Shung and his group members in University of Southern California

A Dialogue between Prof. K. Kirk Shung and the Editor of E-Newsletter Dr. Chih-Chung Huang

Dr. Huang:

I knew that you are so busy. Firstly, I would like to thank you for giving our Taiwanese Society of Biomedical Engineering E-Newsletter an interview. Since you are an authoritative scholar in the medical ultrasound field, could you please give us a brief introduction about the newest development in medical ultrasound?

Dr. Shung: (1) Novel approaches for assessing elastic properties of tissues.
(2) Photoacoustics
(3) Endoscopic devices
(4) Pocket scanners
(5) Wireless probes

Dr. Huang:

I knew that you visited Taiwan several times every year. You definite knew BME is a hot field in both academia and industry in Taiwan. Many universities establishedthe BME departments within these couple years. Could you please comment what is the main difference about the BME education between USA and Taiwan?

Prof. Shung: (1) BME major is very popular for US medical schools
(2) Many courses have design projects including senior capstone projects in the US
(3) American BME graduate programs are now gearing towards system biology, cellular engineering and the like.

Dr. Huang:

Recently, the ROC government is promoting the BME industry in Taiwan. Not only providing a lot of research funding for academia, but also established some institutions to integrate the academia and industry for developing medical devices, such as Taiwan Supra Integration and Incubation Center. Could you please give us some suggestions, if professors in university who want to transfer his/her researches to industry, what is the most important issue they should know?

Dr. Shung: (1) Making sure that time is efficiently managed. Although there are stories that academic people make successful transition into the business world, they are far and few in between. A person cannot be good at both worlds.
(2) Health care industry is lucrative but highly competitive. To be successful, the technology must have the customer in mind.

Dr. Huang:
You are a very authoritative scholar of BME in the world. Could you please give some advices for the young investigators how to become a successful scholar just like you?
Dr. Shung: (1) working hard
(2) having an inquisitive mind, and
(3) broadening one's scientific horizon.
Dr. Huang:
I deeply appreciate you give Taiwanese Society of Biomedical Engineering E-Newsletter an interview. The last question: what is the most impressive thing for you about the Taiwanese Society of Biomedical Engineering?
Dr. Shung: (1) enthusiasm
(2) young people
(3) top-notch research

The 5th World Congress on Bioengineering in National Cheng Kung University, Taiwan. (Dr. K. Kirk Shung (left 4))

臺北市立萬芳醫院醫工組簡介

部門沿革

　　臺北市立萬芳醫院成立於民國八十五年，是由臺北市政府委託臺北醫學大學經營。萬芳醫院扮演著大學醫院角色、健康照護者角色、公辦民營醫院角色之融合體，成功的達成臺北市政府公辦民營的期許與要求。

　　臺北醫學大學承辦萬芳醫院之前，體制內無醫學工程部門。臺北醫學大學附設醫院於民國六十五年創建起，醫療設備即由工務部門負責維護檢修。歷經二十年後，因應附屬醫院增加了臺北市立萬芳醫院，於是在臺北市立萬芳醫院總務室轄下編制醫工組，負責醫療儀器的檢修與管理，成立了臺北醫學大學體系第一個專業醫學工程部門。

組織編制

　　臺北醫學大學體系醫學工程部門，初始由臺北市立萬芳醫院設定醫學工程師二員，民國八十八年增添助理事務員一名，民國九十二年於臺北醫學大學附設醫院成立醫工組，設醫工一員。民國九十七年，協助臺北醫學大學附屬醫院「署立雙和醫院」成立醫工組。目前臺北醫學大學體系附屬三家醫院皆成立醫工組，共轄醫學工程師九名、助理事務員一名，協同支援分頭並進，以因應臺北醫學大學體系各項臨床需求與評鑑檢核。

　　臺北市立萬芳醫院醫工組成立 17 年以來，歷任李顯章（目前任臺北醫學大學勞安室主任）、許銘倫（目前任職臺北醫學大學附醫醫工組）與藍凱（現任）三名組長。現職三名醫學工程師皆為醫學工程系畢業，組內領有臨床工程師、特定化學作業、有機溶劑作業、ISO 儀器校正與管理、ISO 9001 內部稽核員等證照。

核心目標

　　本院自邱文達部長創院之始，即訂定「品質是萬芳的尊嚴」為最高核心目標。期望能達成最高品質之國際醫學大學醫院的願景，建制一個以病人為中心的全人照護、培育菁英人才的大學醫院、卓越創新的研究重鎮，以及國際水準的醫療團隊。

例行業務

　　本組負責業務分為行政管理與設備維護兩大層面：行政管理又分為標準作業流程管理與計劃執行管理兩個追蹤事項；設備維護又分為維修技術與校正保養兩個質量面向。組內備有電刀功率分析儀、用電安全分析儀…等13種檢測設備，以利維護作業結果之正確。

管理優化

為達到環保企業之目標，本組配合全院無紙化推展進程。於民國 97 年完成維修系統 E 化、民國 101 年保養 Bar-code 系統上線，除了達到優化管理的目的之外，更大大降低了紙張的消耗。

本組亦進行以下管理要點確保醫療儀器使用之優化：

一、　　　品質指標之設立。

二、　　　保養合約品質管理監控。

三、　　　設備委外送修控管。

四、　　　設備購入驗收檢測文件歸檔造冊。

五、　　　租賃設備管理。

六、　　　內外部校正文件歸檔造冊。

七、　　　月報資料統計。

除上述七點外，尚有十數件管理執行要點，有效的執行本組管理全院醫療設備，降低醫院成本並創造最大效益。此外，完成了 346 件醫儀設備維護標準化作業流程，更確保了人力運用與執行計劃的精簡。

教學活動

臨床工程不只是醫儀設備妥善率之需求，更肩負有臨床教育之責任。每年平均院內教育訓練約實施 172 場、援外教學約 5 場、國內外實習生約 4~6 名。除了各大專院校醫學工程系與醫務管理系學生之外，本組也代訓馬紹爾與帛流的醫學工程師。另外每年接待十數個參訪團隊，報告與交流彼此醫學工程相關業務經驗。

援外支援活動

因醫學中心責任與醫學大學需求，本組依計劃參與多項援外服務。舉其大者有：馬紹爾共和國三次，協助首都馬九羅醫院設備維護與洗腎室籌建評估計劃；協助浙江大學第二附設醫籌建規劃。

馬九羅醫院大門

李自剛大使合影

協助南京婦幼醫院通過 JCI 評鑑

重要戰役

萬芳醫院醫工組在三任院長領導之下，從民國九十年通過區域醫院評鑑、民國九十三年通過醫學中心評鑑、民國九十五年通過第一次 JCI 醫院評鑑、民國九十七年通過第二次醫學中心評鑑、民國九十八年通過第二次 JCI 醫院評鑑、民國一百零一年通過第三次醫學中心評鑑與第三次 JCI 醫院評鑑、以及數十種國內外各級評鑑的考核。

萬芳醫院完整的醫療质量提升歷程
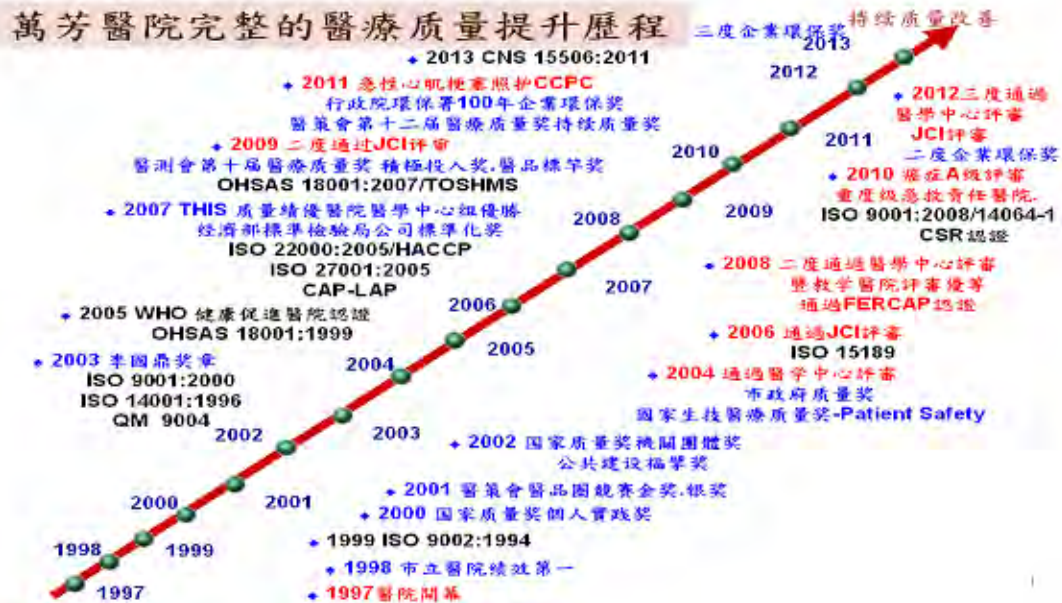
未來展望

臺北醫學大學體系在整合了資訊系統之後，目前正在著手將總務相關業務統合，醫工組正是這一整合中的一項。擬更進一步的將三院醫工組統合成進退一致之整體，更能有效的在之前的協作進退之際，分三院實一體的融合三個單位的資源、數據、技術與計劃。由分頭並進，轉化為群策群力；各自的優點，內化為體系的強項。

專業醫工證照與臨床研究發展是我們目前正在積極加強與拓展的方向，藉由三院資訊整合的進程腳步，相關的醫學工程業務正在學校的指引之下匯聚成型。相信不久之後，北醫體系將會有一個組織更加凝煉、實力更加堅強的醫工組合，協助與參與北醫體系的發展與壯大。

103 年醫工證書換證公告

本會證書每三年需更換一次，每年都有許多會員申請換證，在此特將換證相關規定
(http://www.bmes.org.tw/notice_show.php?id=107)重申如下，敬請詳讀並協助配合！

一、 本會會員：請在證書有效期間內，維持會員資格(每年按時繳納年度會費)。

二、 已持有醫療設備技師及（或）臨床工程師、醫學工程師證書

三、 三年期滿得申請換發：申請書需附上個人二吋證件照片一張。

四、 在最近一年以內仍在職，從事醫儀維修或（及）臨床工程師、醫學工程相關
領域之工作證明(依證書類別)。

五、 申請日前三年內之繼續教育學分

　　1. 每年 10 學分以上。

　　2. 三年 60 學分，其中主要學分 45 學分以上，輔助學分 15 學分以內。

　　　　備考：1. 主要學分：由本學會主辦之相關教育活動所核發之學分。

　　　　　　　　2. 輔助學分：

　　　　　　　　 1) 經本學會認可之國內相關教育活動所核發之學分；

　　　　　　　　 2) 參加國際研討會及相關教育訓練活動證明所核學分

六、 1. 本學會之年度生物醫學工程科技研討會採計主要學分 20 學分

　　2. 國際研討會及相關教育訓練活動證明，每次採計 5 學分。

七、 五月底前申請換證者，證書自當年七月一日生效，十一月底前申請換證者，
證書自次年一月一日生效。

八、 換發證書費 2000 元，劃撥帳號：01850504，戶名：中華民國生物醫學工程學
會蘇芳慶。

九、 本規定經證照甄審委員會同意後實施，修正時亦同。

換證作業方式注意事項：

1) 已經使用於申請證書更換的學分，其學分數需折半計算，使用二次後即歸零。

2) 申請證書更換時，以申請日前三年內所修之教育學分為核算基準。

3) 學分的承可，以簽名為主，請大家參與研討會時，務必至主辦單位或學會攤位
簽到。報名但未簽名者，無法認可該會議之學分。

4) 更換證書所需學分數如下：

申請更換證書數量 (同時申請)	前三年總共所需 累積之學分數
一張	60 學分
二張	90 學分(60/2+60)
三張	120 學分

以上，如有任何疑問，歡迎隨時與學會秘書處聯繫。再次感謝您的支持！

敬祝 業安

　　　　　　　　　　　　　　　　　中華民國生物醫學工程學會秘書處 敬啟

Review: RFID-enabled Applications to Improve the Delivery of Healthcare Services: A Typology and Supporting Technologies

Bendavid Ygal

The adoption of novel technologies such as radio-frequency identification (RFID) along the healthcare value chain are transforming the sector by enabling automatic identification and tracking of products, people, and assets, resulting in real-time visibility and improved efficiency in the delivery of healthcare services. Although a lot of information on RFID applications within the healthcare sector is already available, there is a need to clarify the role of RFID-specific technologies and systems in supporting such innovative healthcare applications. This paper provides a background for healthcare practitioners and researchers to clarify the role of RFID technologies in the healthcare sector. It then proposes a typology of the main RFID-enabled application domains and identifies specific technological designs that support such innovative healthcare applications. The living laboratory approach is used to assess and validate various technological designs that can be selected when envisioning the implementation of such applications.

Accuracy Assessment of Marker-Cluster Registration Method for Measuring Temporomandibular Kinematics Using Cone-Beam Computed Tomography with Fluoroscopy

Chien-Chih Chen, Cheng-Chung Lin, Yunn-Jy Chen, Tung-Wu Lu, Chun-Yu Huang

Accurate measurement of the three-dimensional (3D) kinematics of the temporomandibular joint (TMJ) in vivo is essential for relevant clinical applications. Existing measurement methods are either of limited accuracy, difficult to implement, or interfere with TMJ movement. This study develops a marker-cluster registration method (MCRM) for the measurement of the 3D kinematics of the TMJ using low-radiation-dose dental cone-beam computed tomography (CBCT) with fluoroscopy; and to determine experimentally the accuracy and precision using a porcine cadaveric model. The MCRM uses fluoroscopic images and a marker-cluster model (MCM), derived from the CBCT data, to estimate the spatial poses of the maxilla and mandible, and thus the TMJ. The method was found to have measurement errors of 1.00 mm (standard deviation: 0.68 mm) for all translations and 0.15º (standard deviation: 0.11º) for all rotations. For initial bone poses with root-mean-square target registration errors of 0-50 mm for the maxilla and 0-60 mm for the mandible, the successful registration rate was as high as 99%. With high accuracy and registration rate, the proposed method will be useful for the measurements of the 3D kinematics of the TMJ in vivo for scientific and clinical applications.

Effects of Pregnancy on Progression of Osteoarthritis Induced by Monosodium Iodoacetate in Rats

Kun Zhang, Tanushree Thote, Huijie Leng, Robert Guldberg, Zigang Ge

Hormones, particularly estrogen, are known to play a role in the development of osteoarthritis (OA). In relation to this, the impact of pregnancy on OA remains unknown. Pregnancy leads to decreased expressions of both synthetic and degradation genes of articular chondrocytes, as determined using in vitro tests, but no in vivo studies have been performed exploring pregnancy and OA simultaneously. The present study investigates the effect of pregnancy on the progression of OA in the rat joint degeneration model using an intra-articular injection of monosodium iodoacetate (MIA). Twenty Wistar rats were divided into four groups: A-Pregnancy and intra-articular injection of MIA; B-MIA injection in naive rats; C-Pregnancy, and D-Sham injection of saline in naive rats. Articular cartilage was evaluated 18 days after the detection of vaginal plug in female rats using Janusz's macroscopic score, equilibrium partitioning of an ionic contrast agent via microcomputed tomography, and glycosaminoglycan (GAG) quantification. Results show that there was no significant difference in GAG content, attenuation, volume, and thickness of articular cartilage between pregnant and non-pregnant groups. Contrary to our initial hypothesis, pregnancy does not have observable effects on MIA-induced OA in rats at 3 weeks.

Analysis of Atrial Fibrillation Recidivity Under Successive Attempts of Electrical Cardioversion Based on Fibrillatory Wave Amplitude and Dominant Frequency

Raúl Alcaraz Martínez, José Joaquín Rieta, Fernando Hornero

Atrial fibrillation (AF) is the most common cardiac arrhythmia in clinical practice. One frequent and very effective alternative to revert AF back to a normal sinus rhythm (NSR) is external electrical cardioversion (ECV). However, conventional ECV protocols do not consider effects of electrical shocks on the atrial activity (AA) and its evolution during the procedure. The present study analyzes the feasibility of using the fibrillatory wave amplitude (fWA) and the dominant atrial frequency (DAF), extracted from the AA, to noninvasively detect AF recurrence under successive attempts of ECV and to predict the effectiveness of each shock in the ECV protocols. Results show that the effects of the first ineffective shock are only notably found in the fWA. The percentage of patients who needed several attempts who were correctly classified into patients who relapsed to AF, maintained NSR, and had an ineffective procedure was 64.3% for the fWA analyzed before the first shock, and increased to 89.3% for the same analysis after the first shock. Additionally, by jointly considering the patients who needed only one and several shocks, the discriminant ability increased when the values after the first ineffective attempt were used for the prediction. For the fWA, the diagnostic accuracy increased from 79.4% to 85.7%, for the DAF, from 65.1% to 71.4%, and for their combination, from 82.5% to 87.3%. The effect of the first unsuccessful shock is crucial for determining whether NSR will be restored through successive cardioversion attempts and predicting AF recurrence in patients undergoing ECV protocols. fWA and DAF can thus provide valuable information to improve the effectiveness of conventional ECV protocols, in which the effect of unsuccessful shocks is not taken into account at present.

Physiological Effects of Deep Touch Pressure on Anxiety Alleviation: The Weighted Blanket Approach

Hsin-Yung Chen, Hsiang Yang, Huang-Ju Chi, Hsin-Ming Chen

The application of deep touch pressure (DTP) has been suggested to provide positive effects on anxiety modulation. However, empirical and theoretical evidence linked to the clinical effects of DTP are relatively rare. This study conducts a quantitative analysis of behavioral assessments and performs physiological measurements, including those of electrodermal activity and heart rate variability, to understand the modulation of the autonomic nervous system (ANS), and the orchestration of sympathetic (SNS) and parasympathetic nervous systems (PsNS). The results suggest that the activation of PsNS plays a critical role in ANS modulation. This study provides physiological evidence to support the positive clinical effects of DTP for reducing anxiety in dental environments.

Automated Analysis Method for Screening Knee Osteoarthritis using Medical Infrared Thermography

Chao Jin, Yang Yang, Zu-Jun Xue, Ke-Min Liu, Jing Liu

Osteoarthritis (OA) is a major global health issue due to aging populations. Infrared thermography provides functional information on thermal and vascular conditions of knee joints and can thus be used for knee OA screening. However, the thermal diagnostic procedure for various diseases often requires manual analysis and interpretation, which heavily depends on a clinician's personal experience. In this paper, an automated infrared thermographic analysis method for knee OA screening is developed based on the collected data of normal subjects and outpatients in clinics. 266 knee thermal images (166 normal, 100 abnormal) acquired in the China Rehabilitation Research Centre, Beijing, are used for the first trial. An effective knee feature extraction algorithm based on patella-centering is proposed. The extracted features are fed to a support vector machine (SVM) classifier to perform automated recognition. Experimental results indicate that the SVM classifier has an accuracy rate of 85.49%, a sensitivity of 85.72%, and a specificity of 85.51% in detecting normal and abnormal cases. The proposed automated system for knee thermal screening can thus provide quantitative reference information in assisting clinical diagnosis.

Application of Backwashing to Increase Permeate Flux in Bioparticle Separation
Ali Ostadfar, Andrew H. Rawicz, Mojgan Gitimoghaddam

The aim of this research was to use theoretical data and experimental procedures to determine permeate flux's dependence on time during cross-flow filtration combined with the use of backwashing using permeate in bioparticle separation, specifically in blood filtration. A method that reduces filter membrane fouling for the first stage of blood filtration (plasmapheresis) in an implantable artificial kidney is proposed. The proposed method uses the body's internal energy (blood pressure pulsation) to provide enough movement for the diaphragm pump to make reverse flow as a backwash flow for reducing membrane fouling. The test conditions, which mimicked the human cardiovascular system, were provided by a cardiovascular pump and a hospital monitoring system. The results demonstrate that the membrane backwashing can maintain the permeate flux at a level that is nearly three times higher than the long-term flux without membrane backwashing. The effects of operating parameters such as cross-flow velocity, Womersley number, pressure difference, and filtration time on permeate flux were experimentally investigated. A correlation of the flux to shear rate for frequencies less than 2 Hz (heartbeat of 120 beats per minute) was developed and the results were compared with those obtained using cross-flow filtration techniques.

MAGAT Gel Dosimetry Validation in RapidArcTM Treatment Using Cone-beam CT

Da-Chuan Cheng, Mu-Bai Chung, Tzu-Ching Shih, Ji-An Liang, Yung-Hui Huang, Yueh-Sheng Chen, Tzung-Chi Huang

This study presents the three-dimensional (3D) measurement of the dose distribution delivered using the RapidArcTM technique and MAGAT polymer gel with cone-beam CT (CBCT) as the dose reading tool. 3D verification of clinical prostate quality assurance (QA) plan was performed and analyzed. The MAGAT normoxic polymer gel consisted of methacrylic acid (monomer purity > 98%), gelatin from procine skin (type A, Sigma Aldrich), and tetrakis (hydroxymethyl) phosphonium choloride (THPC) (80% solution in water). A linear accelerator (Varian) with CBCT was used for radiation delivered and CBCT as dose reader. Corresponding QA plans of RapidArcTM plans of two prostate cancer cases were selected for dose comparison measurements. 3D gamma comparisons, dose profiles, and 3D volumes were used for evaluation. The dose response curve of the MAGAT polymer gel was acquired as $x = 9.79y-13154$ with $R^2 = 0.9794$, where y is the CT number and x is the radiation dose in cGy. The 3D gamma analysis was performed using comparisons of volumes in 90% and 80% isodose between treatment planning system calculation and gel phantom measurement for the prostate cases. In the 90% isodose covered volume, 96.3% of points were within 5%/5 mm (dose difference/distance to agreement) and 91.2% of points were within 3%/3 mm. In the 80% isodose volume, the pass rates were 98.7% and 96.1%, respectively. Excellent 3D dose measurement quality for the RapidArcTM delivery technique was achieved with the MAGAT polymer gel and CBCT scan.

Robotic Vertebral Puncture System for Percutaneous Vertebroplasty

Shinya Onogi, Yoshikazu Nakajima, Tsuyoshi Koyama, Yuichi Tamura, Etsuko Kobayashi, Ichiro Sakuma, Nobuhiko Sugano, Kazuo Yonenobu

A robotic system with an X-ray-translucent end-effector and a passive failsafe mechanism is proposed for percutaneous vertebroplasty (PVP). The proposed system consists of a puncture robot with five degrees of freedom, a workstation for the navigation system, and an optical tracking device. The end-effector of the robot is partially X-ray translucent to allow the needle insertion process to be monitored by an X-ray fluoroscope. The robot has a passive failsafe mechanism for safety purposes. A needle assembly is attached to the robot by four asymmetric contacting parts supported by four springs. To evaluate the puncture accuracy of the system, puncture tests were conducted on 50 pedicles of five polyurethane phantoms simulating human lumbar vertebrae from L1 to L5. Pre-operative computed tomography (CT) volumes were acquired for the respective phantoms and segmented. Surgical plans were made for the respective pedicles by a surgeon. After the system was placed at the experimental table's side and the phantom was fixed on the table, robot calibration and phantom registration were performed. During the experiments, no needles were found to be protruding from the pedicles. The positioning accuracy measured by the optical tracking device was 0.64 mm root-mean-square (RMS) and 1.09° RMS (error range = 0.1-0.98 mm, 0.96-1.36°). After the tests, post- operative CT volumes of the respective phantoms were acquired and the puncture trajectories were analyzed. The puncture errors between the planned and actual trajectories were 1.66 mm RMS and 1.62° RMS (error range = 0.13-4.21 mm, 0.36-2.73°). The results demonstrate the feasibility of safe and accurate punctures with the proposed system.

Development of a Swallowing Electrical Stimulation System for Treatment of Dysphagia in Stroke Patients

Kok-Soon Soon, Ming-Yih Lee, Wen-Wei Tsai, Chih-Feng Lin, Chih-Hao Chen

A swallowing electrical stimulation system (SESS) with four-channel electrotherapy modules was designed specifically for the treatment of swallowing disorders. The present study provides clinical experimental evidence that swallowing function can be restored by strengthening the masseter and digastric muscles with SESS. Eleven stroke patients (9 males, 2 females) were included in the study. Subjects were compared with themselves before and after SESS intervention. Electrical stimulation was applied to the skin above the masseter and digastric muscles in all subjects. Training consisted of 12 sessions of swallowing training, during which the intensity of the muscles of both the sound and affected side was displayed on the SESS screen. The myoelectrical activity of the muscles was recorded before and after the SESS intervention. The results indicated that 8 of the 11 subjects showed significant gains in myoelectrical activity of the muscles following SESS. Improvements in swallowing function were characterized by changes in electromyographic activity relative to the baseline recording and total time spent in each swallowing activity. These observations show the beneficial effects of SESS on the masseter and digastric muscles with the goal of improving swallow function. The subjects showed increased electromyographic activity and a reduction in total time spent in each swallowing activity. These results indicate that restoring swallowing function by strengthening muscles via SESS facilitates improvement in the treatment of dysphagia.

Choi-Williams Distribution to Describe Coding and Non-coding Regions in Primary Transcript Pre-mRNA

Umberto S. P. Melia, Montserrat Vallverdú, Francesc Clarià, Juan J. Gallardo, Alexandre Perera, Pere Caminal

Deoxyribonucleic acid (DNA) information is discrete in both "time" (sequence positions) and "amplitude" (nucleotide values). This permits the use of signal processing techniques for its characterization. The conversion of DNA nucleotide symbols into discrete numerical values enables signal processing to be employed to solve problems related to sequence analysis, such as finding coding sequences. In this work, a numerical conversion method was chosen based on the thermodynamic data of free energy changes ($\Delta G°$) of the formation of a duplex structure of DNA or ribonucleic acid (RNA), associated with the nucleotide sequence pre-mRNA (messenger RNA). The aim of this work was to characterize coding regions (exons) from non-coding regions (introns) using a methodology based on time-frequency representation (TFR). This permits the observation of the evolution of the periodicity and frequency components with time, introducing more variables related to the gene sequences compared to those used in traditional fast Fourier transform analysis. The parameters calculated from TFR are instantaneous frequency and instantaneous power. It was found that instantaneous frequency and power variables in different frequency bands allowed the correct classification between exons and introns with a prediction accuracy of more than 85%.

Arrangement of Joint Distraction and Hinge Alignment During Elbow Dynamization Using an Arthrodiatasis Fixator

Wei-Shiun Lee, Ching-Hong Tan, Shang-Chih Lin, Yeung-Jen Chen, Ching-Kong Chao, Kao-Shang Shih

For the arthrodiatasis technique, a unilaterally hinged fixator is used to treat a post-traumatic elbow. It provides immobilization, distraction, and dynamization to restore elbow functions. An ideal dynamization further necessitates the alignment of both elbow and fixator hinges. This is achieved by the manipulation of a guide pin and fixator joints during the intraoperative and postoperative periods. This study evaluates a method for manipulating the guide pin and fixator joints for elbow dynamization and determines whether the elbow distraction and dynamization are concurrent. Finite element models based on computed tomography images are developed. A detailed discussion about the design and release of fixator joints is given. The results show that at the distraction stage, the fixator-aided distraction causes the guide pin to shift towards the opposite side. Using this pin-shift effect, the fixator hinge can be shifted to align with the elbow hinge. The ideal value of the initial pin shift is about half the distance activated by the distractor. For ideal dynamization, the release of joints with at least 10 degrees of freedom (DOFs) is necessary to align the elbow and fixator hinges in the sagittal and coronal planes. If both the center locus and hinge jiggle of an articulating elbow are stable, however, only the DOF release of the fixator hinge is necessary after both elbow and fixator hinges are aligned. The distracting force results in the elastic deflection of the elbow-fixator-pin construct, inducing distraction loss and pin shift. The preparation for the pin shift and the estimation of both the center locus and hinge jiggle produces significantly better joint distraction and hinge alignment during elbow dynamization.

Enhancement of Chondrogenesis via Co-culture of Bovine Chondrocytes with Demineralized Bone Matrix in Chitosan-alginate Beads

Bibek Chandra Sutradhar, Gyeongmi Hong, Zigang Ge, Gonhyung Kim

Cartilage injury leads to osteoarthritis and subsequent loss of mobility irreversibly if untreated. There is no widely established technology for the functional repair of large osteochondral defects, though some progress has been made in repairing/regenerating cartilage defects. In the present study, bovine chondrocytes were cultured in alginate or chitosan-alginate beads with and without co-culture of demineralized bone matrix (DBM) *in vitro*. After the four systems were maintained *in vitro* for four weeks, the cell morphology, proliferation, sulfated glycosaminoglycan (sGAG) synthesis, and gene expression were evaluated. The typical chondrocytic phenotype was maintained in all beads for the entire four weeks. The proliferation of chondrocytes in chitosan-alginate beads co-cultured with DBM was significantly ($p < 0.05$) higher than that in alginates. Histological analysis showed the typical round, plump morphology associated with an increased number of lacunae in chitosan-alginate beads. The production of sGAG also significantly ($p < 0.05$) increased in quality and quantity and type II collagen gene expression was maintained in the co- culture in chitosan-alginate beads. These results indicate that chondrocytes co-cultured with DBM in chitosan-alginate beads provide a preferred environment for high-density chondrogenesis with matrix synthesis, which may be considered as a sophisticated scaffold model for osteochondral tissue regeneration.

Review: A Survey of Performance and Techniques for Automatic Epilepsy Detection

Lorena Orosco, Agustina Garcés Correa, Eric Laciar

Epilepsy is a chronic neurological disorder of the brain that affects around 50 million people worldwide. The early detection of epileptic seizures using electroencephalogram (EEG) signals is a useful tool for several applications in epilepsy diagnosis. Many techniques have been developed for unscrambling the underlying features of seizures present in EEGs. This article reviews the seizure detection algorithms developed in the last decade. In general terms, techniques based on the wavelet transform, entropy, tensors, empirical mode decomposition, chaos theory, and dynamic analysis are surveyed in the field of epilepsy detection. A performance comparison of the reviewed algorithms is also conducted. The needs for a reliable practical implementation are highlighted and some future prospectives in the area are given. Epilepsy detection research is oriented to develop non-invasive and precise methods to allow precise and quick diagnoses. Finally, the lack of standardization of the methods in the epileptic seizure detection field is an emerging problem that has to be solved to allow homogenous comparisons of detector performance.

Surface Characterization of Bismuth-Doped Anodized Titanium

Dan-Jae Lin, Heng-Li Huang, Jui-Ting Hsu, Tzong-Ming Shieh, Lih-Jyh Fuh, Wen-Cheng Chen

This study characterizes the surface features of an antibacterial titanium surface that has demonstrated antibacterial activity against Aggregatibacter actinomycetemcomitans and methicillin-resistant Staphylococcus aureus. Micro-arc oxidized (MAO) surfaces doped with bismuth were prepared by anodizing titanium in bismuth acetate or bismuth-nitrate-containing electrolytes at 280 V for 3 min bismuth acetate (BA) and bismuth-nitrate (BN) groups, respectively). Scanning electron microscopy (SEM), atomic force microscopy (AFM), and X-ray diffraction (XRD) were used to evaluate the surface topography and phase structures. X-ray photoelectron spectroscopy (XPS) was used to evaluate surface chemical compositions. Ion release after immersion of the titanium over a period of 4 weeks was measured by inductively coupled plasma mass spectrometry (ICP-MS). SEM and AFM images show that the micro-porous morphology and micro-roughness of BA and BN surfaces are similar to those of the control samples. Nano-scale particles on the BN surface were observed in magnified SEM images. The XRD patterns show that the oxide on the titanium surfaces was anatase. The XPS results indicate that most of the bismuth was doped onto the titanium surface to a depth of less than 50 nm. The release rates of Ca, P, and Ti ions are similar among all groups, and the ICP-MS results suggest that there was no release of bismuth ions during the entire 4-week observation period. Our results lead to the conclusion that doping of the MAO titania layer with bismuth changes the surface morphology of this material at the nano-scale. Although bismuth existed at the surface of the titania layer, there was no detectable release of bismuth ions after 4 weeks of immersion.

Effect of Gelatin β-tricalcium Phosphate Sponge with Platelet-rich Plasma on Bone Regeneration in Massive Ulna Defects

Naotake Yamada, Wook-Cheol Kim, Takashi Yoshida, Yoshinobu Oka, Takumi Ikeda, Hiroyoshi Fujiwara, Atsushi Nishida, Ken-Ichi Matsuda, Yasuhiko Tabata, Mitsuhiro Kawata, Toshikazu Kubo

Bone transport and vascularized bone grafts are standard therapies for massive bone defects due to severe trauma and bone resection in osteomyelitis patients. Bone regeneration therapy using growth factors and scaffolds has been attracting attention. This study assesses the efficacy of a gelatin β-tricalcium phosphate (β-TCP) sponge combined with platelet-rich plasma (PRP) for treating massive bone defects in rabbits. Massive bone defects created in the ulnar diaphyses of 30 Japanese white rabbits were treated with either gelatin β-TCP sponge and PRP (group A; n = 10) or gelatin β-TCP sponge alone (group B; n = 10), or received no treatment (group C; n = 10). Radiographic examinations were performed weekly, and Lane-Sandhu X-ray scores were used to compare the groups. Eight weeks after bone defect creation, microcomputed tomography (μCT), bone mineral densitometry, and histological examinations were performed. Radiographs showed that the defects in group A were occupied by new bone, unlike in the other two groups. The Lane-Sandhu X-ray score for group A was significantly higher than those for the other groups starting at an early stage. Three-dimensional μCT images showed that the defects in group A were filled by new bone. Cross-sectional μCT images did not show radial-ulnar fusion at either end of the bone defects in group A, whereas radial-ulnar fusion was observed in the other two groups. Bone mineral density in group A was significantly higher than those in the other groups. Histological images from group A showed continuity of cortical bone with medullary cavity formation at both ends of the bone defects. The gelatin β-TCP sponge has osteoconductivity, a pore structure, mechanical strength, and biodegradability, and provides controlled release of growth factors. The gelatin β-TCP sponge with PRP caused favorable bone regeneration in massive bone defects, and may be a clinically applicable option for treating massive bone defects of long bones.

Finite Element Method for Population Density Approach for Large-Scale Neuronal Networks

Chih-Hsu Huang, Chou-Ching K. Lin, Ming-Shaung Ju

The population density approach has been used for modeling the dynamics of large-scale neuronal networks to consider the stochastic nature of the signal processing in the brain. From the conservation principle, the time evolution of population density can be described by a nonlinear partial differential equation (PDE). The finite difference method (FDM) has been proposed for solving this PDE. However, FDM is sensitive to the density gradient of the solution and is confined to problems that have a regular state space. An irregular state space is always obtained if realistic neuronal models are considered. In this study, the finite element method (FEM) is formulated to solve this PDE and apply it to solve the orientation tuning problem. The results show that when the state space discretization is coarse, FEM retains high accuracy whereas FDM does not. Furthermore, FEM reduces computation time by 90% compared to that required for FDM. In addition, FEM can easily handle the existence of a point source without any modifications. Due to its superior accuracy, efficiency, and consistency, FEM may be a better numerical technique for applying the population density approach to large-scale neuronal networks.

Usability of Portable Patient Monitor in Emergency Medical Services: An Evaluation of The Use Errors Caused by Interface Design

Yi-Sung Kuo, Hsi-Peng Lu, Ting-Kuei Kuo

This paper presents an approach for evaluating the usability of portable patient monitors for emergency medical service and proposes a solution for use errors caused by the operation of physical user interfaces and graphical user interfaces. Cognitive load theory is used to analyze use errors in the operation of advanced patient monitors, potentially caused by the limited time in an emergency, as well as user working experience with restricted working memory in critical situations. This study refers to a simplified operation concept and integrates it into a modular interface design (MID) with easy operation that provides sufficient patient physiological information according to user needs. MID for sophisticated medical equipment effectively reduces the user error rate and expands the scope of application to emergency medical technicians in pre-hospital situations, which is critically important with an aging population and a severe shortage of medical professionals. Furthermore, this paper proves that a usability evaluation through cognitive walkthrough is effectiveness in evaluating interface design during the early design stage in the new product development of a medical device.

An Interconnectivity Index for Osteoporosis Assessment Using X-Ray Images
Khaled Harrar, Latifa Hamami

Osteoporosis is a condition that is characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk. This paper develops an interconnectivity index for trabecular bone microarchitecture characterization for the discrimination of patients with different degrees of osteoporosis. A total of seventy one images of the calcaneus (heel bone) from subjects suffering from osteoporosis at different stages were analyzed. A fractal-based method (lacunarity), which quantifies the porosity of the bone, is used as a comparative tool to estimate correlations between interconnectivity indexes and the disease. Bone features are used to classify the subjects using a support vector machine (SVM) classifier. The correlation between the proposed interconnectivity index and the disease was found to better than that between an existing index and the disease. Statistical analysis results suggest that the proposed parameter is efficient for monitoring bone strength and predicting future fracture risk. Moreover, results obtained using SVM with features from the proposed index provide better accuracy and smaller error for classifying patients compared to those obtained with an existing index.

Objective Measurement of Speech Quality for Hearing Aids

Ying-Hui Lai, Shih-Tsang Tang, Kuen-Shian Tsai, Hsiu-Wen Chang, Shuenn-Tsong Young, Woei-Chyn Chu

Hearing aids are commonly used to overcome impairment associated with hearing loss. Recent surveys have shown that hearing aid users are often dissatisfied with the speech quality. However, only subjective methods (e.g., questionnaires) are used to assess speech quality, and the objective methods used to verify the performance of hearing aids have major limitations. This study proposes an objective method called variations of dynamic range (VDR) score for assessing hearing aid speech quality. The method uses quantitative differences between spectra for aided and unaided speech based on Speechmap. Two experiments were performed in this study: (1) one to verify the correlation between scores for the perceptual evaluation of speech quality (PESQ) and VDR in assessing speech quality produced under three compression ratios (CR) of wide-dynamic-range amplification in one channel, and (2) one to verify that the VDR score is consistent with results from clinical trials in the literature. The experiments involved hearing aids fitted using desired sensation level [input/output] (DSL [i/o]) and adaptive dynamic range optimization (ADRO), and stimulated by speech sounds at moderate and loud levels. The VDR scores were measured using the Audioscan Verifit hearing aid fitting system to assess the speech quality of hearing aids. The results indicate that PESQ scores were 3.56, 2.25, and 1.98, and VDR scores were 2.5, 29, and 36 dB for CRs of 1.0, 2.0, and 4.0, respectively. The VDR and PESQ methods provided similar assessments of speech quality produced by hearing aids fitted for flat mild hearing loss (high and low PESQ and VDR scores, respectively, indicate good speech quality). In addition, the average VDR scores were significantly lower ($p < 0.05$) for hearing aids fitted using ADRO than those for hearing aids fitted using DSL [i/o]. The VDR scores are consistent with PESQ scores for hearing aids with different prescriptions, and are consistent with clinical reports that found the speech quality for hearing aids fitted using ADRO to be higher than that obtained using DSL [i/o]. These results indicate the potential of the VDR score for accurately assessing the speech quality of hearing aids.

Numerical Investigation of Ultrafiltration Profiles in Peritoneal Dialysis with Residual Icodextrin in Blood

Wun-Ching Chen, Cheng-Ze Gao, Ruey-Jen Yang

Icodextrin (ICO) has better biocompatibility and an improved ultrafiltration profile in long-dwell peritoneal dialysis compared to those of glucose. However, the long-term repeated use of a single ICO osmotic agent may cause a change in the peritoneal transport characteristics, leading to a reduction in the ultrafiltration profile. Many studies have shown that such a reduction can be quite significant in some patients. In this study, the factors responsible for this decline are investigated via a series of numerical simulations. The peritoneal transport characteristics and ultrafiltration profile are predicted using a three-pore model. To account for the continuous absorption of ICO from the abdominal cavity during peritoneal dialysis, the three-pore model is modified to accommodate a non-constant concentration of ICO in blood. The simulation results show that the presence of residual ICO in blood results in poorer ultrafiltration behavior. Long-duration and repeated use and exposure to ICO result in a residual concentration of ICO in blood, which changes the mesothelial tissue around the blood capillaries in the peritoneal membrane and causes a reduction in ultrafiltration performance.

Integrated System for Improving Electrical Safety of Biochips

Robert Rieger, Chi-Huai Chang

A safe electrical connection between an integrated circuit and the human body is required for the recording of physiological signals such as electrocardiogram, electronystagmogram, and electromyogram signals. The recording chip is typically connected to the patient through a blocking capacitor, which prevents the flow of direct current in the event of circuit failure. However, in systems with a high integration density, blocking capacitors are inconvenient due to their large size and their effect on the signal transfer function. Therefore, this study proposes a fully integratable functional monitoring scheme which involves applying a test signal to the amplifier input and detecting its presence at the output. In the event of failure, the resulting change in the output voltage is detected and the chip can be switched into a safe state. Test signal addition and extraction circuits are proposed and analyzed. Measurement results are presented to confirm the correct operation in the context of a typical recording front-end.

Determination of Adequate Defibrillation of Ventricular Tachycardia Using Computer Simulation of Electroporation Aftershock Effects on Human Cardiomyocytes

Po-Yuan Chen, Wei Hua Tang, Min-Hung Chen, Ching-Hsing Luo

Electric defibrillation is a life-saving therapy for clinically dangerous ventricular arrhythmias. Unfortunately, direct-current (DC) shock treatment often induces or worsens other tachyarrhythmias. The adverse effects of electric shock delivered to human ventricular cardiomyocytes are not fully understood. This study thus uses computer simulation to investigate the pathogenesis of the electrophoresis in epicardial and endocardial human tissue. The O'Hara-Rudy dynamic human ventricular cell model incorporated with Ohuchi's mathematical DC shock model is used. The effect of electroporation is described as a transmembrane pore, mimicking the reversible breakdown of the cell membrane. The aftershock effects on epiardial and endocardial ventricular cardiomyocytes are evaluated. The effects of delivering shock from the endocardium and epicardium using a multicellular one-dimensional strand model are also investigated. Ventricular tachycardia can be terminated by a low-strength shock to endocardial cardiomyocytes. However, an excessively strong shock to epicardial cardiomyocytes induces early afterdepolarization and is arrhythmogenic. The aftershock effect of the electroporation is serious for epicardial ventricular myocytes. The optimization of defibrillation energy delivery to the maximum membrane potential and the pathogenesis of the aftershock effect during ventricular tachycardia are also investigated. The aftershock effect of electroporation is more serious in epicardial cells than it is in endocardial cells. It is suggested that the DC shock be delivered to endocardium cells before the maximum membrane potential of the epicardial cell in a multicellular one-dimensional strand model is reached, which is before the electrocardiogram R wave spike.

國內研討會：

- Symposium on Engineering Medicine and Biology Applications(2014 SEMBA)
  生醫工程應用研討會
  地點：台北圓山大飯店
  會議時間：2014-01-17 ～ 2014-01-19
  網址：http://cc.ee.ntu.edu.tw/~semba2014/
- The 29th Joint Annual Conference of Biomedical Science
  第 29 屆生物醫學聯合學術年會
  地點：國防醫學院
  會議時間：2014-03-15 ～ 2014-03-16
  網址：http://www.jacbs.org.tw/
- 2014 TREATS 學術研討暨論文發表大會
  地點：臺北醫學大學　醫學綜合大樓
  會議時間：2014-03-29
  網址：http://treats.org.tw/website/

國際研討會：

- ICMBSE 2014 : International Conference on Medical and Biological Systems Engineering
  Dubai, UAE. February 21 - 22, 2014
  http://www.waset.org/conference/2014/02/dubai/ICMBSE

- 7th International Joint Conference on Biomedical Engineering Systems and Technologies
  Eseo, Angers, Loire Vally, France. Mar. 3 - Mar. 6, 2014.
  http://www.biostec.org/

- Rehacare & Orthopedic China 2014
  Poly World Trade Center, Guangzhou, China. Mar. 29 – Mar. 31, 2014.
  http://www.chinaexhibition.com/Official_Site/11-4389-R_and_OC_2014_-_Rehacare_and_Orthopedic_China_2014.html

- MONTREAL'2014: AES-ATEMA 17th International Conference.
  Montreal, Canada. June 16 - 20, 2014.
  http://aestr2014.com/

- The XX Congress of the International Society of Electrophysiology and Kinesiology(ISEK 2014 Biennial Congress)
  Rome, ITALY. July 15 – 18 2014.
  http://isekconference2014.com/

- TORONTO'2014: AES-ATEMA 18th International Conference
  Toronto, Canada. August 11 – 15, 2014.
  http://aestr2014.com/

- The 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC'14)
  Sheraton Hotel & Towers, Chicago, Illinois, USA. August 26-30, 2014.
  http://embc.embs.org/2014/

- 12th International Conference of Numerical Analysis and Applied Mathematics (ICNAAM 2014)
  Rodos Palace Hotel, Rhodes, Greece. Sep. 22 - Sep. 28, 2014.
  http://www.icnaam.org/

- The 1st Global Conference on Biomedical Engineering held with the 9th APCMBE.
  National Cheng Kung University, Tainan, Taiwan. Oct 9 – 12, 2014.
  http://conf.ncku.edu.tw/apcmbe9/index.html

- The 16th IEEE International Conference on e-Health Networking, Application & Services (IEEE Healthcom 2014)
  Natal, RN Brazil. Oct. 15 - Oct. 18, 2014.
  http://www.ieee-healthcom.org/index.html

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