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FROM TAWARA TO SUPERIOR SLOW PATHWAYS: CONTRIBUTIONS FROM THE ASIA-PACIFIC REGION TO AVNRT RESEARCH

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Introduction

The story of atrioventricular nodal reentrant tachycardia (AVNRT) research can, in many ways, be traced back to Japan. In 1906, while studying in Germany, the Japanese pathologist Sunao Tawara identified the atrioventricular node and demonstrated its continuity with the His–Purkinje conduction system.[1] This landmark discovery established the anatomical foundation upon which our current understanding of AVNRT is built and marked one of the earliest major contributions from the Asia-Pacific region to the field of cardiac electrophysiology.

Over the following century, investigators across the Asia-Pacific region repeatedly reshaped concepts of AVNRT through pioneering anatomical, electrophysiological, and clinical studies. From the discovery of dual atrioventricular nodal pathways and their anatomical substrates to the recognition of multiple nodal extensions and novel slow pathway variants, these contributions have progressively revealed the anatomical and functional complexity of the AVNRT circuit.

In this article, we trace how the Asia-Pacific region has progressively revealed the anatomical and functional complexity of the AVNRT circuit.

The Emergence of Dual Pathway Physiology

A major breakthrough in AVNRT research came from the work of the Taiwanese electrophysiologist Delon Wu. During his training in the United States, Wu established the concept of dual atrioventricular nodal pathways in humans and helped formulate the now-accepted paradigm that typical slow–fast AVNRT utilizes two functionally distinct pathways, namely the fast and slow pathways, within the atrioventricular nodal region (figure 1).[2]

Figure 1: Professor Delon Wu (left) and Professor San-Jou Yeh (right) at Chang Gung Memorial Hospital, Taiwan, circa 2000. Professor Wu made pioneering contributions to the concepts of dual atrioventricular nodal pathways and catheter ablation of AVNRT, while Professor Yeh played a leading role in advancing the understanding of atypical AVNRT and multiple AV nodal pathways. Photograph courtesy of Professor Kazuo Matsumoto, Editor-in-Chief of the Journal of Arrhythmia.

Subsequently, another Taiwanese investigator working in the United States, Ruey J. Sung, provided the first clinical electrophysiological evidence that the atrial end of the slow pathway was located inferior to the compact atrioventricular node.[3] Although seemingly simple, this observation had profound implications. It provided the theoretical basis for selectively interrupting slow pathway conduction without damaging the fast pathway, thereby eliminating slow–fast AVNRT while preserving normal atrioventricular conduction.

This concept directly inspired the development of surgical slow pathway resection by the Australian cardiac surgeon David Ross[4] and later contributed to the evolution of catheter-based slow pathway ablation. Notably, after returning to Taiwan, Delon Wu independently developed a catheter ablation strategy targeting the slow pathway at approximately the same time as pioneering groups in North America and Europe.[5]

Although these studies established the physiological basis of dual AV nodal pathways and led to the development of curative therapy, the precise anatomical substrate of the slow pathway remained uncertain.

Human Mapping Studies and the Functional Anatomy of AVNRT

A major contribution from Australia came from the work of Mark McGuire and colleagues, who used high-density endocardial mapping of the human heart to address several longstanding controversies regarding the AVNRT circuit. Through a series of studies combining intraoperative mapping, surgical intervention, experimental electrophysiology, and histology, they provided some of the first direct insights into the functional anatomy of AVNRT.

Their initial studies challenged the prevailing concept of a discrete upper common pathway. By demonstrating that different forms of AVNRT could be selectively abolished by surgical interruption of distinct regions of perinodal atrial tissue, they showed that perinodal atrial myocardium is an integral component of the reentrant circuit.[6]

Subsequent high-resolution mapping of Koch’s triangle further identified distinct atrial exit sites for fast and slow pathway conduction. Retrograde fast pathway activation emerged near the apex of Koch’s triangle close to the His bundle, whereas retrograde slow pathway activation exited near the coronary sinus orifice, providing direct evidence for anatomically separate atrionodal inputs.[7]

McGuire and colleagues also investigated the origin of the double potentials that were increasingly being used to guide slow pathway ablation.[8] They demonstrated that these signals do not represent the slow pathway itself, but rather arise from asynchronous activation of adjacent myocardial and nodal-like tissues. In subsequent studies, they further showed that the electrophysiological properties of atrioventricular junctional tissues do not necessarily correspond to their histological appearance, emphasizing that anatomical structures alone cannot fully explain AV nodal physiology.[9]

Collectively, these studies established the importance of perinodal atrial myocardium, clarified the anatomical localization of fast and slow pathway exits, explained the origin of double potentials, and highlighted the complex relationship between structure and function within the atrioventricular junction. More broadly, they transformed AVNRT from a purely electrophysiological concept into a circuit that could be mapped and anatomically defined.

Anatomical Substrates of the Slow Pathway

While physiological and mapping studies had suggested the existence of distinct atrionodal inputs and perinodal tissues, their anatomical substrates remained incompletely understood. A major advance came from the work of Shin Inoue and colleagues, who re-examined the human atrioventricular junction using detailed histological techniques.[10]

Interestingly, Sunao Tawara had already described nodal tissue extending inferiorly from the compact atrioventricular node in his original anatomical studies.[1] However, the potential significance of these structures remained largely unrecognized for nearly a century. During his fellowship in the Netherlands, Inoue, together with Anton E. Becker, identified the right inferior extension as the most likely anatomical substrate of the slow pathway.[10] At the same time, they described the left inferior extension, a previously overlooked structure whose electrophysiological significance would only become apparent years later.

These observations provided the anatomical basis for slow pathway conduction and introduced the concept of multiple nodal extensions, which would become a central theme in subsequent AVNRT research.

Insights into the AVNRT Circuit from Atrial Stimulation During Tachycardia

The response of AVNRT to atrial stimulation during tachycardia has long been recognized as a valuable tool for both diagnosis and mechanistic investigation. Notably, many of the pioneering studies in this field originated from the Asia-Pacific region.

Among the earliest contributions was the work of Lai and colleagues from Taiwan, who examined the effects of atrial stimulation delivered from various sites during AVNRT.[11] Their observations provided evidence for the existence of an excitable gap within the tachycardia circuit and represented one of the first systematic analyses of atrial pacing responses during AVNRT.

Subsequently, Yamabe and colleagues from Japan investigated the resetting response to single atrial extrastimuli delivered from sites both inside and outside Koch's triangle.[12] By comparing the return cycles following stimulation from different atrial locations, they demonstrated that atrial myocardium intervenes between the fast and slow pathways. Based on these findings, they argued against the presence of a discrete upper common pathway, a concept that had long been debated in the AVNRT literature. Yamabe later extended these observations to fast–slow and slow–slow forms of AVNRT,[13,14] providing further evidence that perinodal atrial tissue plays an important role in the tachycardia circuit.

More recently, Park and colleagues from Korea examined the prevalence of an upper common pathway using a similar methodological approach in the largest reported series of patients with typical slow–fast AVNRT (126 patients).[15] They concluded that an upper common pathway was absent in the vast majority of cases (96.0%), further supporting the concept that atrial myocardium is an integral component of the reentrant circuit.

An alternative line of investigation was pursued by Satoh and colleagues from Japan.[16] Using rapid atrial pacing during AVNRT, they demonstrated constant atrial fusion during tachycardia, providing additional evidence against the presence of an upper common pathway. Their study was also notable for showing that constant fusion can occur even in AVNRT, despite its relatively small reentrant circuit.

Remarkably, the influential studies by Yamabe and Satoh were conducted not at large academic research centers but in community hospitals. Within the Japanese electrophysiology community, these works are widely regarded as examples of how careful physiological observations and creative experimental design can yield insights of international significance.

Beyond Dual Pathway Physiology: Multiple Pathways and Atypical AVNRT

From the 1990s onward, investigators from the Asia-Pacific region continued to uncover increasing complexity within the AVNRT circuit. Building upon the dual pathway concept, both the Wu group[17,18] and the emerging Shih-Ann Chen group[19] in Taiwan independently accumulated compelling clinical evidence supporting the existence of a third functional pathway, giving rise to the concept of triple AV nodal pathways consisting of fast, intermediate, and slow pathways. Their large clinical series demonstrated that triple and even quadruple AV nodal pathways were not uncommon, challenging the traditional dual-pathway paradigm. Among these contributions, Wu's proposed "figure-of-eight" model was particularly influential[17]. This elegant concept suggested that different pathways within the atrioventricular nodal region could alternately serve as the essential limb of the reentrant circuit, while others functioned as bystander pathways. The model provided a mechanistic explanation for the coexistence of multiple forms of AVNRT in a single patient and offered new insights into the dynamic roles of nodal pathways during tachycardia. These observations marked an important shift from the traditional dual-pathway paradigm toward a more complex view of the atrioventricular nodal region, in which multiple pathways may coexist and participate in a variety of reentrant circuits. This concept would later form the basis for understanding atypical AVNRT and the growing spectrum of slow pathway variants.

The lower common pathway, located distal to the reentrant circuit in atypical AVNRT, plays an important role in the diagnosis of these tachycardias because it can influence both the tachycardia phenotype and its response to programmed stimulation. Wu and colleagues provided elegant clinical evidence for the existence of the lower common pathway by demonstrating atrioventricular block occurring during ongoing tachycardia while the tachycardia itself remained unaffected.[20,21] This simple but convincing observation established the lower common pathway as an important component of atypical AVNRT.

Slow Pathway Variants and the Contemporary View of AVNRT

Since the beginning of this century, investigators in the Asia-Pacific region have continued to expand the spectrum of slow pathway variants. Nam and colleagues from Korea were the first to demonstrate clinically a leftward extension of the slow pathway.[22] Subsequently, Kiyoshi Otomo and colleagues from Japan systematically characterized the electrophysiological features and catheter ablation outcomes of fast–slow AVNRT utilizing this left-sided slow pathway as the retrograde limb.[23,24] Their pioneering work was widely recognized internationally and established this entity as a distinct subtype of AVNRT.

More recently, investigators from Japan reported the existence of a superior slow pathway extending superiorly within Koch's triangle.[25] This observation has since been confirmed by several groups, predominantly in Japan, and is now widely accepted as another important slow pathway variant. We subsequently described additional slow pathway variants extending toward the tricuspid[26,27] and mitral annuli.[28]

Taken together, these findings suggest that the various slow pathway variants originate from atrial myocardium derived from the embryonic atrioventricular ring, which retains the characteristic electrophysiological properties of slow conduction and ATP sensitivity.[28] Because this tissue also serves as the substrate for ATP-sensitive atrial tachycardia, we have proposed the concept of atrioventricular ring tachycardia, encompassing a spectrum of tachycardias arising from the arrhythmogenic atrioventricular ring (figure 2).

These discoveries represent the latest step in the evolution of AVNRT research, transforming the traditional concept of a single slow pathway into one of multiple anatomical and functional variants distributed around the atrioventricular junction. AVNRT is no longer viewed as a reentrant circuit utilizing a single fast and slow pathway, but rather as a spectrum of reentrant arrhythmias arising from multiple atrionodal connections and AV ring–derived myocardial substrates.

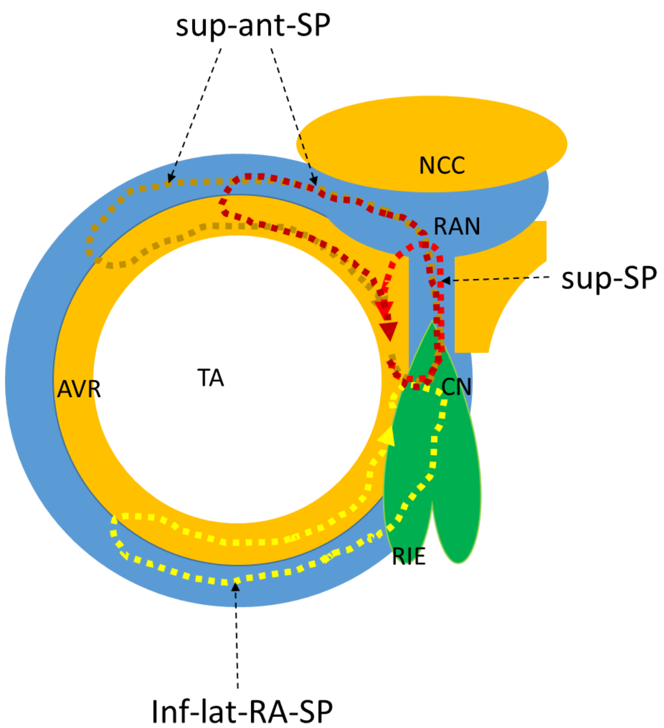

Figure 2: Schematic illustration of atypical fast–slow AVNRT circuits utilizing slow pathway variants. The atrioventricular ring (AVR) surrounding the tricuspid annulus (TA) is continuous with the right inferior extension (RIE) of the AV node and the retroaortic node (RAN) located posterior to the non-coronary sinus of Valsalva (NCS). The inferolateral right atrial slow pathway (inf-lat-RA-SP), superior slow pathway (sup-SP), and superoanterior slow pathway (sup-ant-SP) are formed by different combinations of these structures and serve as the retrograde limb of the inferolateral, superior, and superoanterior types of fast–slow AVNRT, respectively. Reproduced from Reference 29 with permission.

Conclusion

From Tawara's discovery of the atrioventricular node to the contemporary concepts of multiple nodal extensions and slow pathway variants, investigators from the Asia-Pacific region have repeatedly reshaped our understanding of AVNRT. Their pioneering anatomical, electrophysiological, and clinical studies have not only advanced mechanistic insights but have also directly influenced the diagnostic approaches and catheter ablation strategies used worldwide.

Perhaps the most distinctive contribution of the Asia-Pacific region has been the progressive revelation of the anatomical and functional complexity of the AVNRT circuit. Over the past century, the concept of AVNRT has evolved from a simple reentrant circuit utilizing dual pathways within the AV node to a heterogeneous group of tachycardias involving multiple atrionodal connections, nodal extensions, and AV ring–derived myocardial substrates.

The history of AVNRT research is, in many respects, the history of progressively uncovering the complexity of the atrioventricular junction—a journey to which investigators from the Asia-Pacific region have made some of the most enduring contributions.

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THE ROLE OF CLINICAL ENGINEERS IN ARRHYTHMIA CARE IN JAPAN

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The Japanese Medical Licensing System and Clinical Engineers

Medical care in Japan is supported by multidisciplinary teams composed of healthcare professionals with a variety of national licenses. In addition to physicians and nurses, radiological technologists, clinical laboratory technologists, physical therapists, pharmacists, and other professionals participate in clinical practice within the scope of duties defined by relevant laws and regulations.

Among these professionals, clinical engineers (CEs) are nationally licensed healthcare professionals whose profession was established under the Clinical Engineers Act, which was enacted in 1987. Under Japanese law, CEs are responsible for the operation, maintenance, and inspection of life-support equipment under the direction of physicians. As medical devices have become increasingly advanced and complex, CEs have come to play an important role in modern medical practice.

In Japan, approximately 30,000 CEs currently work in clinical settings. Their duties cover a wide range of fields, including medical equipment management, blood purification therapy, respiratory care, extracorporeal circulation, mechanical circulatory support, intensive care, endoscopic procedures, operating room support, and cardiac catheterization laboratory procedures. Among these areas, arrhythmia care is one of the fields in which the expertise of CEs is particularly important.

This article introduces the roles of CEs in arrhythmia care in Japan, focusing on catheter ablation and cardiac implantable electronic device (CIED) therapy.

Role of Clinical Engineers in Catheter Ablation

In Japan, catheter ablation is performed by multidisciplinary teams consisting of cardiologists, nurses, radiological technologists, clinical laboratory technologists, and CEs. Catheter ablation requires the use of numerous advanced medical systems, including three-dimensional mapping systems, intracardiac electrogram recording systems, radiofrequency generators, programmable stimulators, intracardiac echocardiography systems, and defibrillators. Specialized knowledge and technical skills are essential for the safe and efficient operation of these systems.

In many Japanese institutions, CEs are responsible for the inspection, preparation, and maintenance of equipment related to catheter ablation. Before each procedure, they prepare the system configuration according to the planned procedure and patient characteristics. After the patient enters the electrophysiology laboratory, CEs often assist with the placement of electrocardiographic electrodes and patches for three-dimensional mapping systems, the preparation of physiological monitoring systems, and the preparation of ventilators when respiratory support is required. In some specialized centers, CEs are also involved in the segmentation of preprocedural computed tomography (CT) or magnetic resonance imaging (MRI) data.

During the procedure, CEs operate intracardiac electrogram recording systems, three-dimensional mapping systems from different manufacturers, and programmable cardiac stimulators. They also assist with the settings and monitoring of radiofrequency generators and irrigation pumps. By communicating with the operator in real time and presenting electrogram information, anatomical information, and three-dimensional mapping images, CEs contribute to the development of treatment strategies and the smooth progress of the procedure.

In particular, catheter ablation for complex atrial tachycardia and ventricular tachycardia requires advanced electrophysiological knowledge, including mapping during tachycardia, assessment of abnormal electrograms, substrate mapping, and detailed map analysis. With the development of high-density mapping and image integration technologies, CEs are now expected not only to operate medical devices but also to appropriately interpret acquired electrogram and mapping data and provide this information to the operator.

In recent years, the use of pulsed field ablation (PFA) for atrial fibrillation has rapidly expanded, and catheter ablation is entering a period of major transformation. PFA has a mechanism of action that differs from that of conventional thermal ablation, such as radiofrequency ablation and cryoballoon ablation. Therefore, a sufficient understanding of each system's characteristics and procedure-specific workflow is essential for safe and effective treatment. Because each device has different features and safety considerations, CEs are required to continuously update their knowledge and adapt to new technologies.

Role of Clinical Engineers in Cardiac Implantable Electronic Device Therapy

Cardiac implantable electronic device (CIED) therapy is an essential component of arrhythmia care. It includes pacemakers for bradyarrhythmias, implantable cardioverter-defibrillators (ICDs) for life-threatening ventricular arrhythmias, and cardiac resynchronization therapy (CRT) for patients with heart failure. In recent years, device therapy has become increasingly advanced and complex with the introduction of leadless pacemakers, subcutaneous ICDs (S-ICDs), extravascular ICDs (EV-ICDs), and conduction system pacing.

In Japan, CIED therapy is supported by multidisciplinary device teams composed of cardiologists, nurses, CEs, and other healthcare professionals. In recent years, the importance of specialized device nurses, who are involved in patient education, lifestyle guidance, and remote monitoring, has also increased. However, the availability of such personnel varies among institutions. Therefore, in many hospitals, CEs are broadly involved in CIED care, from implantation procedures to outpatient follow-up and remote monitoring management.

During implantation procedures, CEs operate device programmers and perform measurements using pacing system analyzers, including lead impedance, sensing amplitudes, and pacing thresholds. They also support safe and appropriate CIED therapy by suggesting device settings to physicians according to each patient's clinical condition and therapeutic goals.

In outpatient clinics, CEs perform functional assessments of CIEDs and analyze arrhythmic events, ICD-delivered therapies, and heart failure-related device parameters. They also review information on patient symptoms and remote monitoring data, report the findings to physicians, and thereby contribute to device optimization, assessment of therapeutic effects, and appropriate clinical decision-making.

In remote monitoring management, CEs contribute to the early detection of arrhythmic events, lead abnormalities, and battery depletion. When abnormal findings are detected, they promptly share information with physicians and nurses and help coordinate outpatient visits or additional examinations, thereby contributing to patient safety.

Thus, CEs in Japan are continuously involved in CIED care, from implantation procedures to outpatient follow-up and remote monitoring management. As core members of the device team, they collaborate with multiple healthcare professionals and contribute to improving the quality and safety of device therapy.

Conclusion

As described above, CEs in Japan play an important role in catheter ablation and CIED therapy. In the field of catheter ablation, they support the development of treatment strategies through the operation and management of advanced medical equipment, as well as through the analysis of electrophysiological information and three-dimensional mapping data. In the field of CIED therapy, they are continuously involved from implantation procedures to outpatient follow-up and remote monitoring management, thereby contributing to improved quality and safety of care.

Arrhythmia care in Japan is supported by multidisciplinary teamwork involving physicians, nurses, CEs, clinical laboratory technologists, radiological technologists, and other healthcare professionals. Within this team, CEs are not merely operators or maintenance personnel for medical equipment. Rather, they play an important role as professionals who convert device-derived information into clinically meaningful support.

CEs also actively participate in academic societies and research meetings, including those organized by the Japanese Heart Rhythm Society (JHRS). They are involved in education and research activities, and in some research meetings, CEs take leading roles in planning and management. Through these activities, they contribute to the education of younger healthcare professionals, inter-institutional exchange, and the promotion of multidisciplinary collaboration.

The continuous involvement of CEs in three-dimensional mapping support during catheter ablation, CIED implantation, long-term follow-up, and remote monitoring management is one of the distinctive features of arrhythmia care in Japan. CEs are expected to continue contributing to the development of arrhythmia care as important members of multidisciplinary arrhythmia teams in the Asia-Pacific region.

Figure legend

Figure 1. Clinical engineers during catheter ablation. Two CEs operate three-dimensional mapping systems and intracardiac electrogram recording systems to support the procedure. At our institution, we use four types of three-dimensional mapping systems—CARTO 3, EnSite X, OPAL, and AFFERA—and CEs are responsible for operating and managing all of them. One characteristic of CEs in Japan is their ability to support three-dimensional mapping systems from multiple manufacturers and operate each system with an understanding of its specific features. This represents an important area of expertise in arrhythmia care.

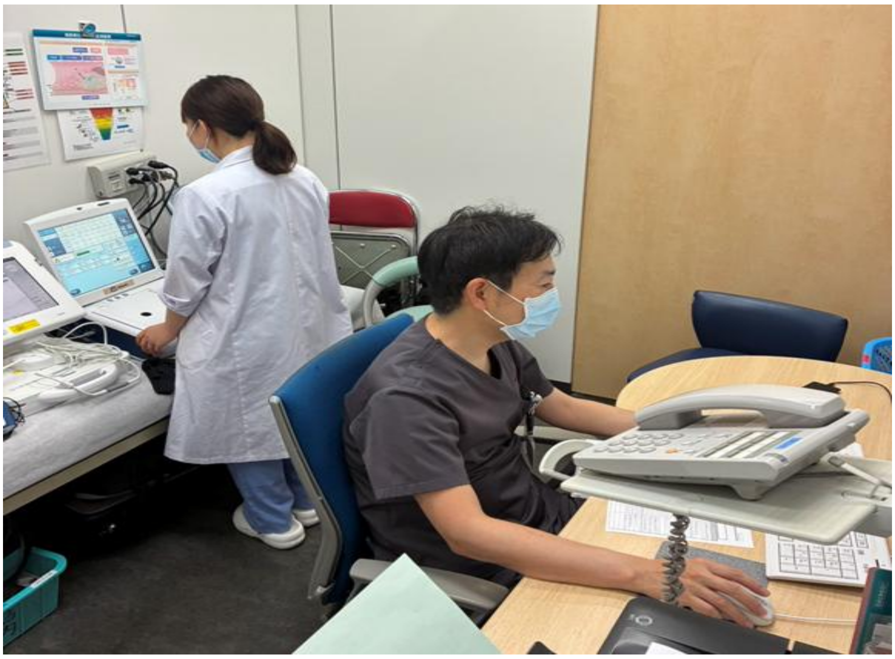

Figure 2. CIED follow-up in the outpatient device clinic. Cardiologists and CEs collaborate in outpatient CIED care. CEs are responsible for operating device programmers from various manufacturers and performing functional assessments of CIEDs. To improve the efficiency of outpatient care, CEs review remote monitoring data in advance and identify patients who may require clinical intervention or who have device-related events before the clinic visit.

Figure 3. A lecture at the Co-medical Arrhythmia Dojo. The Co-medical Arrhythmia Dojo is a research and educational meeting for allied healthcare professionals involved in arrhythmia care, including CEs, clinical laboratory technologists, and nurses. The word "dojo" originally comes from Buddhism and means "a place to pursue the way." Today, it is widely known as a place for martial arts training, but it is also used to describe a place where knowledge and skills are learned in a practical manner and where continuous self-improvement is encouraged. Through lectures, case presentations, and discussions, this meeting aims to improve knowledge and skills in arrhythmia care while promoting multidisciplinary collaboration and inter-institutional exchange.

Figure 4. A special lecture at the 67th Saitama Arrhythmia and Pacing Research Meeting. This regional meeting has been held continuously since 1992 and provides a forum where not only physicians but also healthcare professionals from multiple disciplines can discuss arrhythmia care beyond professional boundaries. At this meeting, the author, a CE, served as the meeting president. This was the second time that a non-physician healthcare professional had served as the meeting president. The special lecture, entitled "CRT Implantation Using Non-contrast Computed Tomography," was delivered by Daigo Tokudome, CE, from the Department of Clinical Engineering, Yokohama Rosai Hospital.

JHRS ECG CERTIFICATION EXAMINATION INITIATIVE

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Here, we introduce the ECG Certification Examination organized by the Japanese Heart Rhythm Society (JHRS). This examination is designed to assess participants' ECG interpretation skills by having them answer questions based on electrocardiograms.

The importance of ECG interpretation for healthcare professionals cannot be overstated. However, ECGs are by no means relevant only to highly specialized experts. The ECG Certification Examination Committee was established in 2012 with the aim of increasing the number of people interested in ECGs, disseminating a broad range of ECG-related knowledge, and ultimately contributing to improvements in the quality of healthcare. The initiative was originally conceived by Professor Hideo Mitamura. The examination is currently administered by 17 members of the ECG Certification Examination Committee, with an additional 68 physicians involved in preparing examination questions.

The first ECG Certification Examination was held in 2015 at a single venue in Tokyo and attracted just under 1,000 candidates for Levels 2 and 3 combined. From the second examination, Level 1 was added and the number of test sites was increased, with the total number of candidates exceeding 2,000. By the fourth examination in 2018, more than 5,200 candidates had taken the examination. To further broaden participation among younger generations, including medical and nursing students, and to encourage them to develop an interest in ECGs, Level 4 was introduced in 2019 (Figure 1). Candidates who pass Level 4 receive a distinctive pink badge. The number of candidates declined only in 2020, when seating capacity was restricted because of the COVID-19 pandemic, but subsequently recovered steadily. The number exceeded 11,000 in 2022, reached 23,000 at the 10th examination in 2024, and increased further to 28,000 at the 11th examination in 2025 (Figure 2).

Four examination levels

50 questions · 70 min (Level 4) · 90 min (Levels 1–3)

Figure 1. Four levels of the JHRS ECG Certification Examination. The examination comprises four levels, ranging from Level 4 (basic) to Level 1 (advanced), according to the expected degree of ECG interpretation proficiency. Each level consists of 50 multiple-choice questions; the examination time is 70 min for Level 4 and 90 min for Levels 1–3.

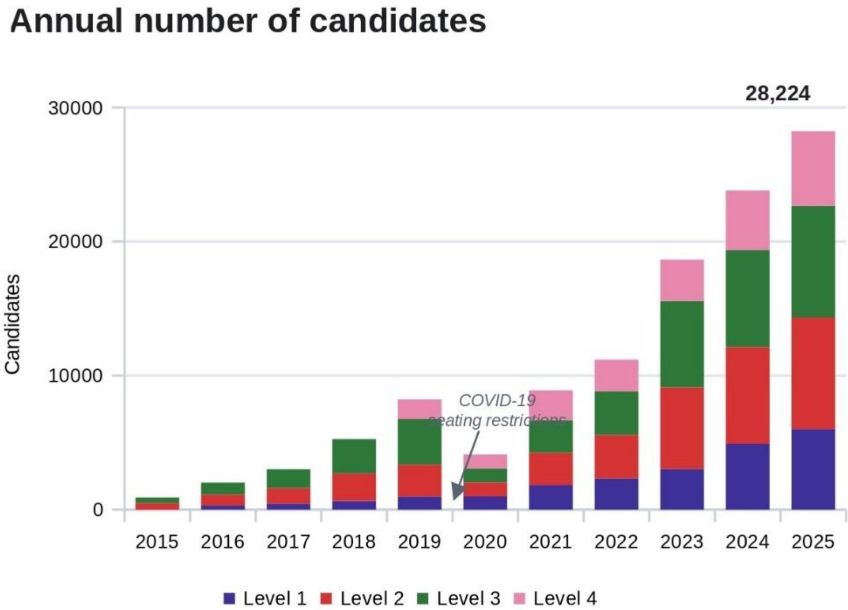


Figure 2. Annual number of candidates for the JHRS ECG Certification Examination. Annual numbers of candidates from 2015 through 2025 are shown according to examination level. Level 4 was introduced in 2019. The temporary decrease in 2020 reflects seating restrictions during the COVID-19 pandemic. The total number of candidates reached 28,224 in 2025.

With regard to candidate demographics, physicians and clinical laboratory technologists account for a large proportion of those taking Levels 1 and 2, although the numbers of nurses and clinical engineers have also been increasing in recent years. Nurses constitute a large proportion of candidates for Levels 3 and 4; however, participation has gradually expanded to include medical students, nursing students, and even students without a healthcare background.

The annual pass rates are generally slightly above 50% for Level 1, 60% for Level 2, 70% for Level 3, and 80% for Level 4. Notably, some students without a healthcare background have successfully passed the examination. Elementary school students have also passed Levels 3 and 4, and an elementary school student has even been recognized as a top performer in Level 4. Candidates who achieve the highest scores at each level are recognized for outstanding performance, and their names are published on the JHRS website. Among the top performers in Level 1, those achieving particularly high scores are designated as “Meisters” and receive special recognition, including a commemorative plaque and a gold badge (Figure 3).

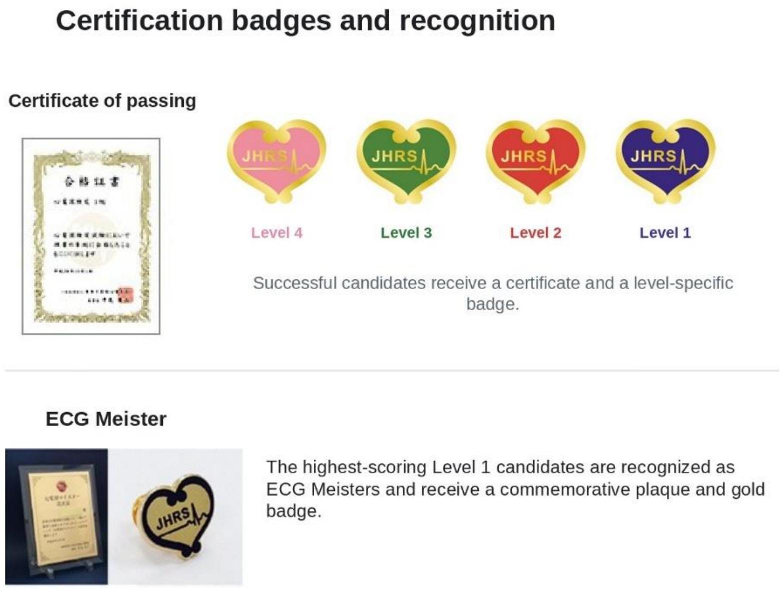


Figure 3. Certification badges and recognition. Successful candidates receive a certificate and a level-specific badge. Among the highest-scoring candidates in Level 1, those with particularly outstanding scores are designated as ECG Meisters and receive a commemorative plaque and a gold badge.

In response to frequent inquiries about how best to prepare for the examination, ECG Certification Examination preparatory courses were launched at JHRS regional meetings in 2021. These sessions have often been filled to capacity even when scheduled early in the morning. Beginning in 2023, the preparatory courses have also been offered at the JHRS Annual Scientific Meeting, and more than 30 such sessions have been held to date. Since 2024, these courses have also been offered at the JHRS Device Winter Meeting and the JHRS Electrocardiology Spring Meeting. In addition, ECG lectures have been organized as joint programs with JHRS at regional meetings of other academic societies, including the Japanese Circulation Society and the Japanese Coronary Association.

As the official study text, the Official ECG Certification Examination Question Book & Guide was published by Medica Publishing shortly before the first ECG Certification Examination. It has since undergone three revisions, with approximately 90,000 copies published to date. At the same time, there has been considerable demand for a collection of questions that were actually used in previous examinations. In response, JHRS plans to edit and publish an official collection of past examination questions in 2027.

For the 12th examination in 2026, Kanazawa will be added as a new test site, marking the examination’s first expansion to the Sea of Japan side of Japan, with approximately 37,000 seats being made available nationwide. A representative examination venue is shown in Figure 4. We hope that an increasing number of people, including those outside the healthcare professions, will become interested in ECGs and that the knowledge they acquire will ultimately prove useful in patient care. Looking further ahead, and speaking from a personal perspective, we hope to continue expanding the ECG Certification Examination, with ambitious goals such as attracting more than 50,000 candidates and eventually holding the examination in every prefecture of Japan.

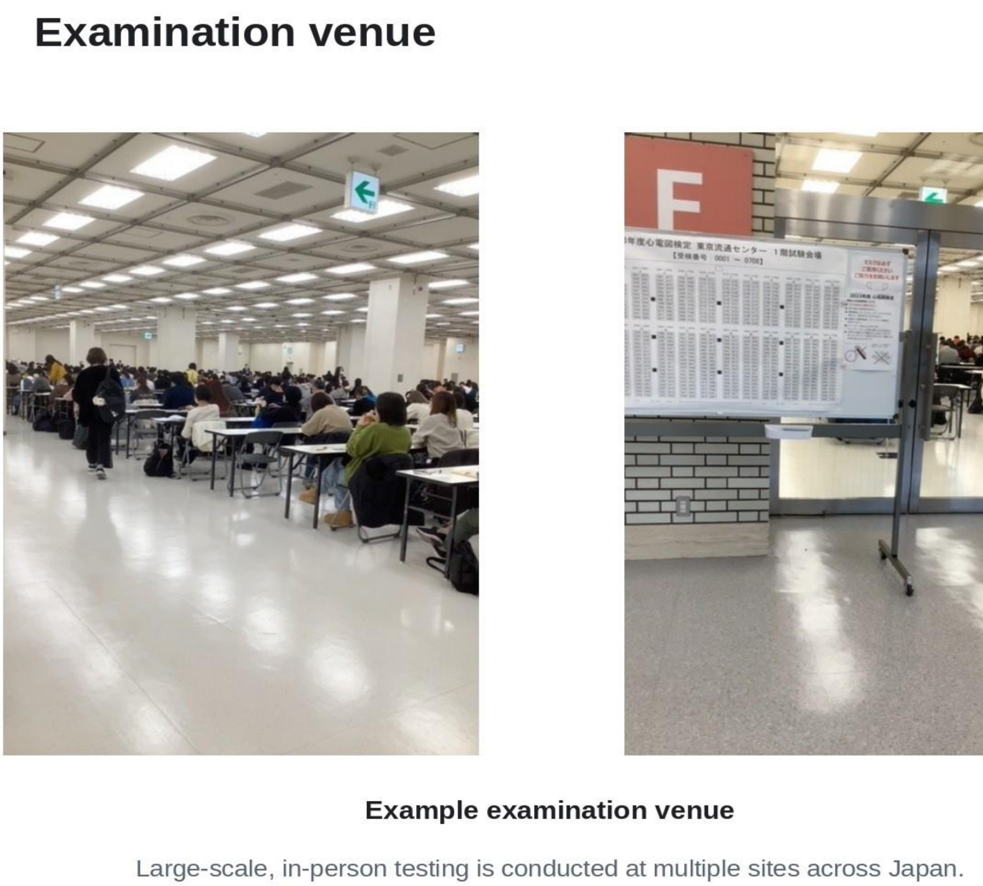


Figure 4. Examination venue. Representative photographs of a large-scale, in-person ECG Certification Examination venue. The examination is conducted at multiple sites across Japan.

APHRS HANDS-ON EP SUPPORT PROGRAM OFFICIALLY LAUNCHED AT THE 18TH VAS-CHINA

Written by: Hailei Liu

The APHRS Hands-on EP Support Program was officially launched on August 1, 2026, during the 18th Ventricular Arrhythmia Symposium of China (VAS-China) in Nanjing, China. As one of the largest dedicated ventricular arrhythmia meetings in China, VAS-China has been held annually for 18 years and brings together approximately 1,000 electrophysiologists and cardiovascular professionals from China and around the world each year. The meeting provides a broad academic platform spanning education, clinical practice, technological innovation, and cardiovascular research, with a particular focus on advances in cardiac electrophysiology and the management of complex arrhythmias.

Against this background of international exchange and education, the launch of the APHRS Hands-on EP Support Program represented an important new step in translating regional collaboration into practical training and capacity building. The dedicated kick-off session brought together more than 20 electrophysiology experts from mainland China, Hong Kong, and Indonesia to discuss regional collaboration, workforce development, and practical approaches to improving electrophysiology services across the Asia-Pacific region.

The session was chaired by Prof. Hung Fat Tse from The University of Hong Kong and Queen Mary Hospital. In his opening remarks, Prof. Wei Hua, President of APHRS, introduced the vision and framework of the Hands-on EP Support Program. Prof. Hua highlighted the substantial burden of cardiac arrhythmias across the Asia-Pacific region and the considerable disparities in access to electrophysiology services among countries and regions. Against this background, APHRS initiated the Hands-on EP Support Program as a country-to-country, practice-oriented support initiative, focusing on hands-on training in catheter ablation, cardiac implantable electronic devices, and electrophysiological mapping, as well as support for EP laboratory development and specialist training. Prof. Hua further introduced the APHRS Fellowship Program, through which young physicians may apply for training at APHRS-accredited centers across the Asia-Pacific region. The program combines short-term academic and clinical exchanges with longer-term institutional support, with participating teams providing on-site guidance in areas such as atrial fibrillation ablation and device implantation.


Indonesia: Challenges and a Ten-Year Vision for Arrhythmia Care

Dr. Erika Maharani, APHRS Council Member and President of the Indonesian Heart Rhythm Society, presented an overview of the current landscape and future development of arrhythmia care in Indonesia.
As an archipelagic country with more than 17,000 islands and a population of approximately 280 million, Indonesia faces substantial geographical and healthcare-access challenges. Although national health insurance covers more than 92% of the population, access to advanced device therapy and electrophysiology procedures remains limited. Indonesia currently has approximately 56–75 electrophysiology consultants, with most EP services concentrated on the island of Java.

Dr. Maharani introduced Indonesia's ten-year national roadmap for arrhythmia care, which aims to expand the electrophysiology workforce to 188 specialists and establish 138 regional centers. She highlighted four major areas for international collaboration: education and training, technological innovation, collaborative research, and healthcare delivery.

Sharing the Experience of EP Center Development in China

Prof. Minglong Chen, Chair of VAS-China and Director of the Cardiac Electrophysiology Program at the First Affiliated Hospital with Nanjing Medical University, shared the development journey of his center.
He described its evolution from the early 1990s, when two-dimensional mapping systems and reusable ablation catheters were used, to its current status as a high-volume electrophysiology center equipped with advanced EP laboratories. The center now performs approximately 5,500 catheter ablation procedures and nearly 1,200 device implantation procedures annually.

Prof. Chen also introduced the center's clinical and educational experience, including individualized substrate-based ablation strategies for persistent atrial fibrillation, management of complex arrhythmias, structured weekly teaching activities, journal clubs, and online education. He expressed the center's willingness to work closely with Indonesian colleagues and to contribute to EP training and technology dissemination through the APHRS platform.

Strengthening Regional Collaboration Through Practical Training

During the panel discussion, participants exchanged views on sustainable collaboration models, fellowship training, and opportunities for young electrophysiologists. Prof. Kejiang Cao commented that the current stage of EP development in Indonesia shares similarities with the earlier development of electrophysiology in China and that the Hands-on EP Support Program could provide valuable support for building local expertise and infrastructure. Prof. Hailei Liu highlighted that the program creates an important opportunity to strengthen medical collaboration between China and Indonesia, providing a platform for case-based learning, clinical exchange, and technical sharing.

From the Indonesian perspective, Dr. Hauda El Rasyid noted that China's strong EP infrastructure, high-volume centers, and geographical proximity make it a valuable regional training partner for Indonesia. He expressed the hope that more young Indonesian physicians would have opportunities to receive mentorship and advanced electrophysiology training in China under the APHRS framework.

From Kick-off to Long-Term Partnership

The launch of the APHRS Hands-on EP Support Program marks an important step toward translating regional collaboration into practical and sustainable action. By combining hands-on education, institutional partnerships, fellowship opportunities, and long-term capacity building, the initiative aims to create broader opportunities for knowledge sharing and clinical training while supporting the next generation of electrophysiologists. Through the APHRS platform, participating centers will work together to facilitate the sharing of practical expertise, adapt training to local needs, and ultimately improve access to high-quality arrhythmia care throughout the Asia-Pacific region.

The successful kick-off in Nanjing represents not only the beginning of a new training initiative, but also a shared commitment across the APHRS community to learn together, grow together, and advance heart rhythm care across the region.

SU SU* EP LAB IN CAMBODIA

Written by: Suk-Kyu Oh

Greetings to all readers of the APHRS Newsletter; it is a great pleasure to connect with you. My name is Suk-Kyu Oh, and I completed my cardiac electrophysiology (EP) training at Korea University Anam Hospital under the esteemed guidance of Professor Young-Hoon Kim and Professor Jong-Il Choi. Since 2020, I have been living and serving in Cambodia, and I would like to share my journey here by answering a few short questions.

1. What motivated you, as a South Korean, to choose Cambodia?

My primary motivation for moving to Cambodia was my deep passion for calling as medical missionary. Even before entering medical school, I had a strong desire to live a life that pleases God, and I committed to fully surrendering my life to Him as a missionary. Around the completion of my EP training, as I was prayerfully considering where to share the Gospel and serve local people with medical care, I visited Cambodia, Vietnam, and Mongolia. Ultimately, God placed a special heart for Cambodia in me, which led me to begin my journey here.

2. What was the situation like when you first arrived? Was it environment-ready for performing EP procedures, and what was the condition of the hospital lab?

When I first arrived in Cambodia, EP procedures were not possible at Hebron Medical Center, where I currently work, because the angiography machine was out of order. At that time, Calmette Hospital was the only medical institution in the entire country equipped to perform EP procedures.

Figure 1. EP procedure at Hebron Medical Center in 2018 with Dr. Chun Hwang

** "Su Su" means "Cheers" in Khmer language*


Figure 2 & 3. EP Procedure at Calmette hospital in 2018 with Dr. Melvin Scheinmann, Dr. Chun Hwang, Dr. Sung Wook Han

3. What is the approximate demand or patient population awaiting EP procedures in Cambodia?

Similar to the prevalence rates seen in other Southeast Asian country, Cambodia has a significant number of patients suffering from arrhythmias, including bradyarrhythmia, SVT, AF, and VT, who are in urgent need of procedures. However, because many impoverished patients cannot afford these high-cost treatments, the number of procedures actually performed falls short of the vast population requiring them. Fortunately, the government-led national health insurance system, the NSSF (National Social Security Fund), is gradually expanding, and coverage for catheter ablation and pacemaker implantations is steadily rising.

4. How did you select your current hospital, and how did you go about setting up the EP lab?

Hebron Medical Center, where I currently serve, is a mission hospital founded by Korean medical missionaries for local evangelism. Prior to COVID-19, EP and device procedures had been performed here through visiting medical teams. Because it already had a foundational framework for these procedures, it was the perfect option for me to step in and serve, which led to my decision to choose this hospital.

However, when I first began my ministry at Hebron Medical Center, we faced numerous challenges: due to COVID-19, visiting teams from Korea could not come for over three years, and the angiography machine was completely out of order. To overcome this, I consulted with the leadership team to purchase a new angiography machine and began training our local nurses. Thanks to the invaluable support of Dr. Chun Hwang from the United States and many professors from the Korea Heart Rhythm Society, we successfully finalized the setup and were finally able to perform our first procedure in 2024.

5. What were the challenges you faced during the setup process, and what was the most difficult part?

The challenges were largely twofold. First, because no procedures had been performed for a long time, all the nurses and technicians who had experience in electrophysiology had resigned, meaning I had to train a completely new nursing team from scratch. Teaching them everything from the very basics of the procedures to the handling of various specialized equipment and catheters was highly challenging.

Second, the installation of the angiography machine posed a significant hurdle. In Korea, where global medical technology company have a direct presence, equipment procurement, contracting, and shipping proceed relatively smoothly. In Cambodia, however, we had to navigate this process through local distributors, which introduced many difficulties. Furthermore, because it was right after the recovery from COVID-19, international shipping faced major delays, and it took about a year and a half after signing the contract to finally complete the machine's setup.

Figure 4. Our dedicated nurses & technicians in the newly established EP Lab in Hebron Medical Center

Figure 5. First procedure following the installation of the new angiography machine at Hebron Medical Center in 2024

6. Did you receive any support from the APHRS or its member countries? If so, how did you communicate with them?

Through the "APHRS Country-to-Country Matching EP Aid Project" originally initiated in 2017 by my esteemed mentor, Dr. Young-Hoon Kim (APHRS newsletter No.31), numerous EP labs across Cambodia have received substantial and invaluable support from the Korea Heart Rhythm Society (KHRS). In a concrete demonstration of this commitment, the KHRS officially established Memorandums of Understanding (MOUs) with major local institutions equipped with EP labs, including Calmette Hospital, Khmer-Soviet Friendship Hospital, and Hebron Medical Center. Since 2022, as the global COVID-19 situation stabilized, KHRS professors have been conducting bi-annual medical missions to Cambodia. During these visits, they not only helped us physically set up our EP labs and install our 3-D mapping systems, but they also worked side-by-side with local Cambodian electrophysiologists to perform complex procedures and host comprehensive EP Case Conferences, offering immense clinical and educational support.

Furthermore, the Travel Grants provided during the APHRS Scientific Meetings have offered a vital platform for many Cambodian physicians and nurses to acquire advanced clinical knowledge and keep pace with the latest global breakthroughs in arrhythmia management.

Figure 6. MoU between KHRS and Khmer-Soviet Friendship Hospital in 2022

Figure 7. MoU between KHRS and Hebron Medical Center in 2022

Figure 8. MoU between KHRS and Calmette Hospital in 2023

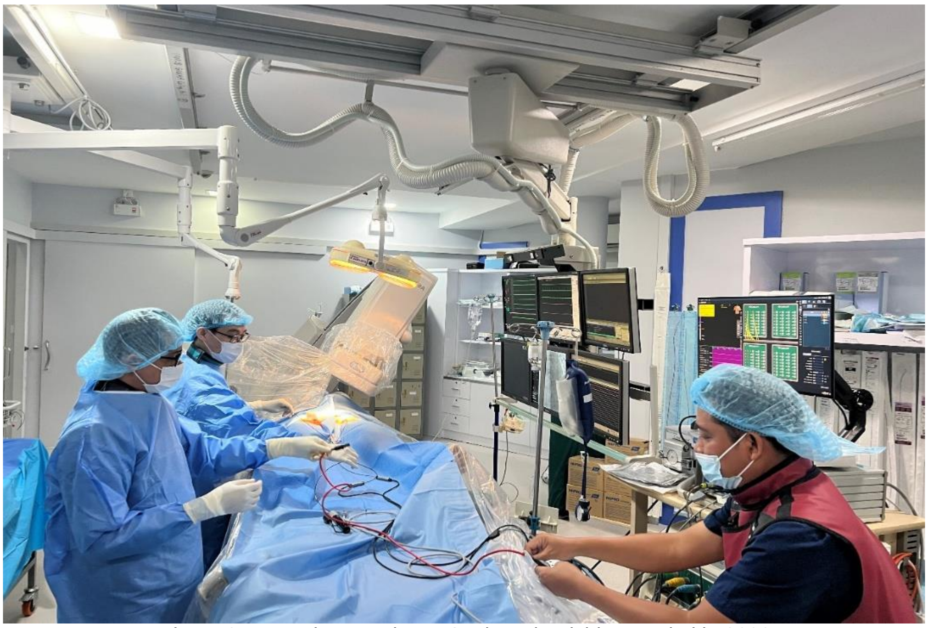


Figure 9. Procedure at Khmer-Soviet Friendship Hospital in 2022

Figure 10. Procedure at Calmette Hospital in 2023

Figure 11. EP Case conference in 2025

7. Compared to the beginning, how much progress has the current EP lab made?

In the beginning, because our staff had very limited clinical experience, I had to thoroughly brief and prepare them before every procedure and continuously instruct them during the cases. Today, however, as they have accumulated experience, we are now able to perform SVT cases smoothly and without any significant difficulties.

8. What areas are you still focusing on to create an even better environment?

Currently, Cambodia lacks skilled 3-D mapping technicians (Field clinical engineer, FCE), making advanced training in this area an absolute necessity. Therefore, I believe our most pressing priority is to send Cambodian technicians or nurses to Korea or other country to undergo intensive training in 3-D mapping systems.

9. What are your hopes and visions for the future of EP in Cambodia?

My ultimate vision is to alleviate the suffering of poor, marginalized, and afflicted patients through EP procedures, and to share the love of Jesus Christ through this healing ministry. Furthermore, it is my ultimate aspiration to collaborate with more electrophysiologists in Cambodia to collectively advance the field of cardiac electrophysiology across the nation.

10. How are you training and nurturing local Cambodian EP staff?

As Hebron Medical Center is a mid-sized mission hospital rather than a teaching hospital, we do not yet have the capacity or resources to train specialized electrophysiologists (EP doctors). For now, our immediate focus is to thoroughly train our nursing and technical staff so they can effectively assist during EP procedures. My goal is to equip them so robustly that, even if they eventually move to other medical institutions, they will be fully capable of fulfilling their specialized roles. Looking ahead, if the opportunity arises, I hope to collaborate with Cambodian medical universities to formally train and nurture future EP medical staff.

EP LAB SPOTLIGHT: THE ELECTROPHYSIOLOGY TEAM OF SOETOMO GENERAL HOSPITAL

Written by: Makhyan Jibril Al-Farabi, MD, MSc, MBA

Cardiologist – Electrophysiology Division
Soetomo Academic and General Hospital, Surabaya, Indonesia

Hospital Overview

Soetomo Academic and General Hospital is one of the largest tertiary referral and academic hospitals in Eastern Indonesia, located in Surabaya, East Java. Serving as a national referral center, the hospital provides comprehensive and highly specialized healthcare services across multiple disciplines, including cardiovascular medicine and surgery. With its strategic role in a densely populated region, Soetomo Academic and General Hospital plays a critical role in addressing the growing burden of cardiovascular diseases in Indonesia.

In recent years, Indonesia has experienced a rapid epidemiological transition, with an increasing prevalence of non-communicable diseases, particularly cardiovascular disorders and cardiac arrhythmias such as atrial fibrillation. Responding to this challenge, Soetomo Academic and General Hospital continues to strengthen its cardiovascular services through clinical excellence, capacity building, and integration of advanced medical technologies.

Figure 1. Soetomo General Hospital, Surabaya, Indonesia

Electrophysiology Laboratory

The Electrophysiology Laboratory at Soetomo Academic and General Hospital functions as a dedicated unit for the evaluation and treatment of complex cardiac arrhythmias, combining advanced procedural capabilities with patient-centered care. The laboratory is designed to support a wide range of electrophysiology procedures while maintaining high standards of safety, efficiency, and clinical outcomes.

The Electrophysiology (EP) Division of Soetomo Academic and General Hospital was established to provide advanced diagnostic and therapeutic services for patients with cardiac arrhythmias. The EP Lab focuses on comprehensive arrhythmia management, including invasive electrophysiology studies, catheter ablation, and device-based therapies, delivered in an integrated and systematic manner.

The laboratory operates within modern catheterization facilities shared with interventional cardiology services and is equipped to support a broad spectrum of electrophysiology procedures. Available infrastructure and technology are continuously optimized to ensure procedural accuracy, patient safety, and efficient workflow during complex interventions.

The EP team is led by consultant cardiologists with formal training in electrophysiology and is supported by skilled nurses, technicians, and multidisciplinary collaborators. Since 2021, the EP Division has been actively expanding its service capacity, clinical volume, and procedural complexity, positioning itself as one of the biggest and emerging electrophysiology centers in Eastern Indonesia.

Figure 2. Members of the arrhythmia and electrophysiology team at Dr. Soetomo General Hospital, Surabaya, Indonesia.

Facilities and Technology

The EP Lab at Soetomo Academic and General Hospital is equipped with modern catheterization laboratories shared with interventional cardiology services. Available facilities and technologies include:

- Advanced fluoroscopy systems
- Three-dimensional electroanatomical mapping systems
- Radiofrequency ablation technology
- Pulsefield ablation technology
- Comprehensive cardiac rhythm monitoring and recording systems
- CIED including conduction system pacing

The integration of these facilities allows the electrophysiology laboratory to perform both routine and complex procedures with a high level of precision and efficiency. Continuous optimization of equipment and workflow supports safe procedural execution, enhances operator performance, and contributes to improved clinical outcomes. These facilities enable the EP team to safely and effectively perform a wide range of electrophysiology procedures tailored to patient needs.

Clinical Services and Procedures

The EP Division provides a broad spectrum of services, including:

- Diagnostic electrophysiology studies
- Catheter ablation for supraventricular tachycardia, PVC and atrial fibrillation
- Evaluation and management of complex arrhythmias
- Pacemaker including CSP, CRT, implantable cardioverter-defibrillator (ICD) implantation and follow-up

The clinical focus of the EP Lab continues to evolve in line with national needs, with particular emphasis on atrial fibrillation management and arrhythmia-related stroke prevention.

Figure 3. Catheter ablation procedure performed at the electrophysiology laboratory of Soetomo Academic and General Hospital with proctorship from Harapan Kita Hospital

The EP division has been able to offer EP lab technologies to hundreds of patients annually up to this point. Nearly 150 patients require the installation or replacement of a CIED (Cardiac Implantable Electronic Device) each year. The goal of the installation of these devices is to enhance the quality of life for patients or even saving life. Each month, 40-60 of patients undergo EP studies and ablations, using either 2D or 3D mapping technology.

There are several advance medical procedures in the field of arrhythmia that have been made. The CSP (conduction system pacing) is regularly performed with satisfactory results. The goal of this latest pacemaker technology is to enhance the efficiency of the pacemaker and minimize the risk of side effects. The capacity for the ablation procedure also increases significantly with the use of 3D mapping technology. As a result, the operator will have an easier time accessing the arrythmia focus points that are located in the difficult location. Several treatments have also been performed to prevent sudden cardiac death, including the implantation of an ICD in Brugada syndrome or septal ablation in HOCM (Hypertrophic Obstructive Cardiomyopathy).

Academic and Professional Activities

Although primarily a clinical service unit, the EP Division actively contributes to academic development and research. Team members are involved in clinical research, scientific publications, and national as well as international conferences. The division's consultants have published extensively in peer-reviewed journals and actively participate in professional societies and educational activities. Annually, we published 10-20 EP research in Scopus indexed journal.

In addition, members of the EP team contribute to healthcare policy, medical education, and public health communication at regional and national levels, reflecting the hospital's broader mission beyond clinical care.

Figure 4. APHRS 2024 Delegates from Indonesia

Figure 5. International Proctorship for PFA Ablation

Figure 6. EP Team in Surabaya at RUA INAHRS 2025

Vision and Future Development

The Electrophysiology Division of Soetomo Academic and General Hospital aims to further strengthen its role as a regional center of excellence in cardiac electrophysiology. Future development plans include increasing procedural volume, expanding advanced ablation techniques, enhancing fellowship programs, and fostering regional and international collaboration to improve patient outcomes and advance arrhythmia care in Indonesia.

Conclusion

Through participation in the EP Lab Spotlight segment, the Electrophysiology Team of Soetomo Academic and General Hospital hopes to share its experience, contribute to regional knowledge exchange, and support the continuous growth of electrophysiology services within the Asia-Pacific region.

Hospital Information

Soetomo Academic and General Hospital
Jl. Prof. DR. Moestopo No.6-8, Airlangga, Kec. Gubeng, Surabaya, East Java, Indonesia

GETTING TO KNOW: DR XIAOHAN FAN

M.D., Ph.D. Cardiac Arrhythmia Center, National Center for Cardiovascular Disease, Fuwai Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College

APHRS Allied Professional Committee Chair

Why did you choose to enter medicine and above all, prefer to specialize in Electrophysiology?

I chose medicine, driven by a desire to combine science with meaningful human impact. Electrophysiology particularly attracted me because it translates precise electrical mechanisms into immediate clinical benefit. In EP, a well-executed intervention can restore rhythm, improve quality of life, or even be lifesaving within minutes. The field requires deep physiological understanding, technical skill, and thoughtful decision-making qualities. I find both intellectually stimulating and clinically rewarding.

What do you regard as the most significant development in Electrophysiology in the recent past?

One of the most significant recent developments is the shift toward more physiological pacing strategies, such as left bundle branch pacing and Bachmann pacing. These approaches challenge the long-standing reliance on right ventricular pacing (RVP) or right atrial appendage pacing (RAAP) and have demonstrated clear benefits for ventricular synchrony and cardiac function. This evolution reflects a broader trend in EP: from simply treating arrhythmias to optimizing long-term cardiac physiology and patient outcomes.

Can you talk about an accomplishment that you are particularly proud of?

I am particularly proud of contributing to the clinical adoption and standardization of novel pacing techniques, including physiological and leadless pacing strategies. Through clinical research, teaching, and hands-on training, our team has enhanced procedural safety and outcomes, especially in heart failure patients. Seeing these techniques move from early experience to routine practice, and benefiting patients on a daily basis has been deeply fulfilling.

If you could have an alternative career, what would it be and why?

If I were not a physician, I would likely choose a career in engineering or applied physics. These fields share a similar problem-solving mindset with electrophysiology and emphasize precision, innovation, and system optimization. In many ways, EP already feels like a bridge between medicine and engineering, and I greatly enjoy this technical aspect of my work.

Who has inspired you the most in your life and why?

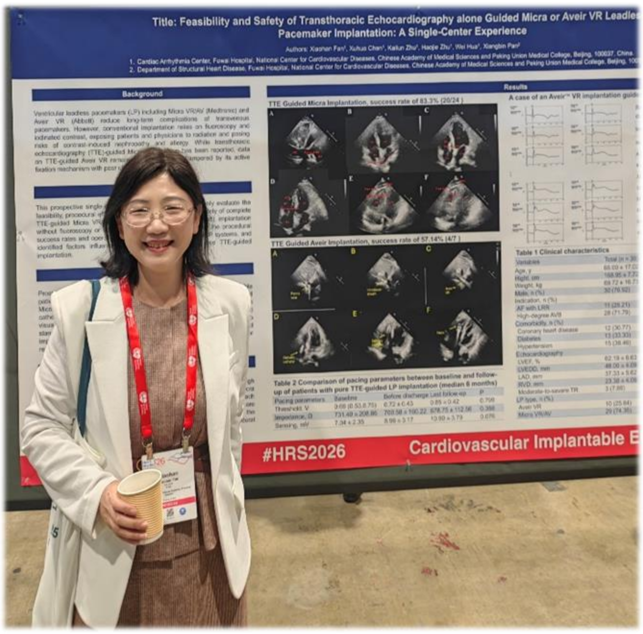
I have been most inspired by my mentors in cardiology and electrophysiology. They demonstrated not only exceptional clinical skill, but also integrity, curiosity, and commitment to patient care. Their ability to balance clinical excellence with academic rigor and mentorship shaped my own approach to medicine. More importantly, they taught me how to think critically and responsibly as a physician, which guides my daily practice.

What is the funniest thing that has happened to you recently?

Recently, during a teaching procedure, a trainee confidently explained a complex electrophysiology concept—only to realize midway that he was describing the wrong chamber. We all paused, laughed, and used the moment as a learning opportunity. It was a gentle reminder that even in a highly technical field, humility and humor are essential, and mistakes can often become the most memorable lessons.

What is your best life advice, motto or favorite quote?

One principle I strongly believe in is: “Be precise in what you do, and honest about what you do not know.” In medicine, precision saves lives, and honesty builds trust—with patients, colleagues, and ourselves. This mindset encourages continuous learning and helps maintain professional integrity throughout a long medical career.



What are your hobbies and interests outside of medicine?

Outside of medicine, I enjoy reading, traveling, and spending time with my family. Reading—particularly history and biography—helps me maintain perspective beyond the hospital. Traveling allows me to appreciate different cultures and healthcare systems, which is especially valuable in an international field like electrophysiology. These activities help me stay balanced and return to clinical work with renewed focus and energy.

What advice would you give to your younger self?

I would advise my younger self to be patient and build strong fundamentals. Early in one’s career, it is easy to pursue speed and recognition, but true expertise takes time. I would also emphasize the importance of finding good mentors and learning from both successes and failures. Finally, it is essential to remember that medicine is a lifelong journey, not a race, for long-term fulfilment.

What are your thoughts about some of the emerging technologies, and the way they will shape the future care of arrhythmia patients?

Emerging technologies—such as leadless pacing, advanced mapping systems, imaging integration, and artificial intelligence—are rapidly reshaping arrhythmia care. These tools will enable more personalized, precise, and minimally invasive treatments. However, technology should complement rather than replace sound clinical judgment. The future of electrophysiology lies in combining technological innovation with a deep understanding of cardiac physiology and patient-centered decision-making.

REPORT ON APHRS-EHRA IMMERSION PROGRAM

Written by: Naruepat Sangpornsuk

My Experience in the APHRS–EHRA Immersive Program at Herz- und Diabeteszentrum NRW

Looking back to March, I was excited to receive an email from APHRS informing me that I had been awarded a grant to participate in the APHRS–EHRA Immersive Program. I was assigned to Herz- und Diabeteszentrum NRW (HDZ NRW) in Bad Oeynhausen, Germany. Initially, I had never heard of Bad Oeynhausen. I had always assumed that major electrophysiology (EP) centers would be located in large cities such as Berlin, Munich, or Frankfurt. After receiving the placement, I began searching for information about both the hospital and the city through Google and ChatGPT. I soon discovered that despite being located in a small town, HDZ NRW is one of the highest-volume centers for catheter ablation and cardiac device implantation in Germany. I contacted Professor Philipp Sommer, who responded to my email almost immediately with great kindness. I would also like to sincerely thank Ms. Kreft for her excellent assistance in preparing all the documents required for my observership.

When I first arrived in Bad Oeynhausen, I found it to be a peaceful and charming town. It was difficult to imagine that such a world-renowned EP center was located here. At Herz- und Diabeteszentrum NRW, there are three dedicated EP procedure rooms: two for catheter ablation and one for device implantation. Each room performs approximately four to six procedures per day. From my very first day, I received an exceptionally warm welcome from the EP team, especially Dr. Moneeb and Professor Sohn. I was assigned to stay exclusively in the EP laboratory throughout the program, allowing me to observe every procedure that interested me.

The majority of procedures performed at HDZ NRW are atrial fibrillation (AF) ablations, which are my area of interest. What impressed me in AF ablation is that pulmonary vein isolation (PVI) is only one part of the overall treatment strategy, with many additional approaches tailored to each patient's substrate. The center routinely performs pulse field ablation (PFA), including both single-shot and point-by-point techniques. Remarkably, HDZ NRW has already adopted virtually every commercially available cutting-edge PFA technology worldwide, including the dual-energy STSF focal PFA catheter, which had only recently received FDA approval in July 2026.

Because of my particular interest in AF ablation, I closely observed the entire procedural workflow. Nearly every patient underwent pre-procedural cardiac CT imaging, allowing operators to evaluate pulmonary vein anatomy and anatomical variations before entering the laboratory. I believe this is particularly valuable for current single-shot PFA procedures and is something that could potentially be adopted at my own center. In Thailand, procedural costs remain an important consideration, and single-shot PFA is still commonly performed under fluoroscopic guidance alone. Another aspect that surprised me was that transseptal puncture was routinely performed under fluoroscopic guidance without intracardiac echocardiography, primarily because of cost considerations. Instead, the operators relied on contrast injection and pressure monitoring to ensure procedural safety. I was especially impressed when Dr. Moneeb successfully performed transseptal puncture in a patient with a previously implanted atrial septal defect occluder. He kindly explained the technique to me and shared his publication in Heart Rhythm describing transseptal puncture in patients with ASD occluder devices. During the PVI procedures, I had the opportunity to observe the use of multiple PFA platforms. I was particularly grateful to Dr. Thomas Fink for allowing me to scrub into one of his cases, where I could closely observe every step of the procedure. He generously shared many practical tips, procedural nuances, and common pitfalls associated with each ablation catheter. These invaluable discussions gave me a much clearer understanding of the advantages and limitations of different technologies and have already influenced which catheters I hope to use once they become available in Thailand.

One unforgettable experience was the opportunity to handle many of these devices after the procedures had finished. Since most of these technologies are not yet available in Thailand, this hands-on experience was extremely valuable. Beyond the academic knowledge, I was also inspired by the dedication of the entire EP team. Procedures routinely started around 7:30 a.m. and continued until approximately 5:00–6:00 p.m., demonstrating an impressive commitment to patient care.

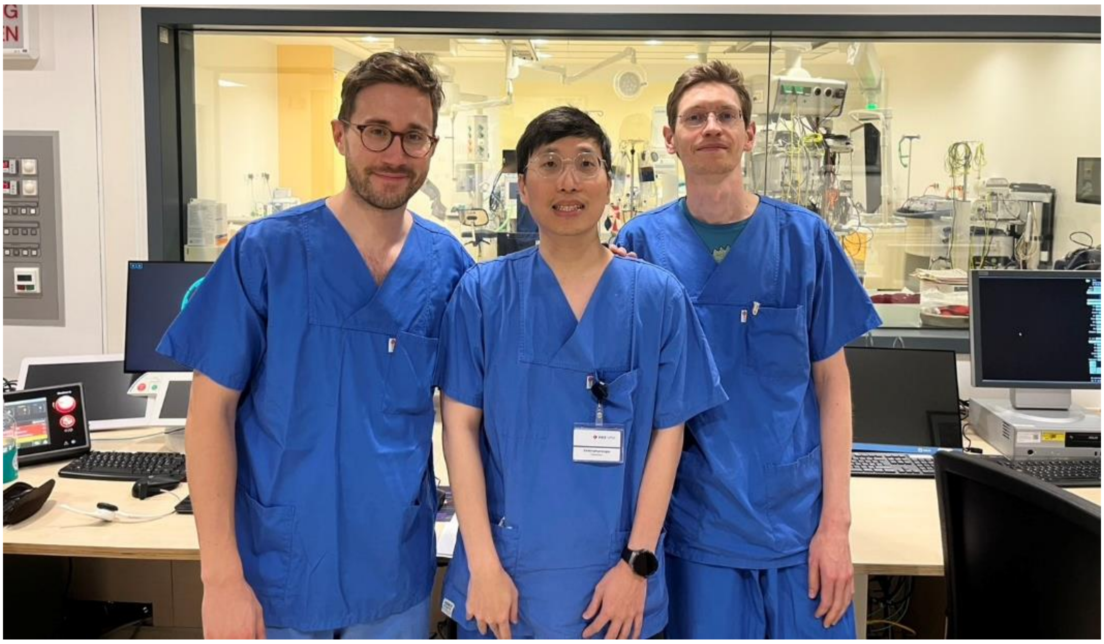
During my second week, I primarily observed procedures performed by Professor Sommer, who is internationally recognized for his expertise in AF ablation. His EP fellows were incredibly kind and consistently explained each step of the procedures whenever they had the opportunity. During the remainder of my observership, I also observed ventricular tachycardia (VT) ablation, supraventricular tachycardia (SVT) ablation, and cardiac device implantation, particularly leadless pacemakers.

The VT program at HDZ NRW was especially impressive because the center performs a remarkably high volume of complex VT procedures, almost every day, compared with my own institution. I observed several challenging cases, including scar-related VT ablation and idiopathic non-outflow tract premature ventricular complex (PVC) ablation. One of the most valuable lessons I learned was their routine preference for the transseptal approach for left ventricular access. In my own practice, I have primarily used the retrograde aortic approach, so observing the transseptal technique greatly broadened my perspective. I gained several practical techniques that I hope to incorporate into my future VT procedures. For SVT, I observed a few cases, all of which were atrioventricular nodal reentrant tachycardia (AVNRT).

Device implantation procedures were performed in a dedicated device laboratory, with all patients managed under the care of an anesthesiologist. I observed implantation of the new Biotronik leadless pacemaker, which achieves atrioventricular synchrony by using a new technology and needs only ventricular implantation. I was also fascinated to observe the implantation of the Medtronic conduction system pacing (CSP) ICD lead. I believe this technology has tremendous potential to reduce unnecessary conventional cardiac resynchronization therapy (CRT) implantation while minimizing the total number of implanted leads. Once again, I would like to sincerely thank Dr. Thomas Fink for allowing me to closely observe his implantation of a dual-chamber ICD using a CSP ICD lead.

Overall, participating in the APHRS–EHRA Immersive Program has been one of the most valuable experiences of my professional career. As a young electrophysiologist from a developing center in Thailand, this opportunity allowed me to gain knowledge, practical experience, and exposure to advanced technologies that are currently unavailable in my country. Beyond learning new procedural techniques, I was inspired by the team's dedication to clinical excellence, innovation, and education. I will bring these experiences back to my institution and adapt what I have learned to further improve arrhythmia care for our patients. I sincerely appreciate APHRS and EHRA for providing this exceptional opportunity, and I hope this outstanding program will continue to support many more young electrophysiologists across the Asia-Pacific region in the years to come.

Thank you once again to APHRS, EHRA, Professor Sommer, Professor Sohn, Dr. Moneeb, Dr. Thomas Fink, Ms. Kreft, and the entire EP team at Herz- und Diabeteszentrum NRW for making this observership an unforgettable experience.

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