

Innovative Approaches to Congenital Heart Disease

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In the last two decades, tremendous progress has been made in the diagnosis and treatment of even complex congenital heart disease (CHD). These advances would not have been possible without the exponential gain of knowledge in the field of heart development, the pathophysiologic/hemodynamic delineation of structural cardiovascular lesions, and the discovery of many important basic mechanisms underlying disease development and progression. In this special issue of the *Journal of Clinical and Experimental Cardiology (JCEC)*, internationally renowned experts from multiple disciplines comprehensively discuss and summarize the most impactful discoveries and innovations in the fascinating field of CHD that have emerged in the last 5 years.

All articles of this issue underwent rigorous peer review. Nevertheless, the pieces - intentionally - contain personal views and perspectives. While we, the special issue editors, could have added several more papers, we did not strive to fully cover all aspects of CHD but rather intended to create a compilation of papers that will be useful for the majority of pediatric and adult cardiologist, cardiac surgeons, physicians of other disciplines, physician scientists, and basic researchers with a particular interest in cardiovascular development and genetics, pulmonary vascular and congenital heart disease. We were truly impressed by the quality of each of the invited manuscripts, and at this point, would like to express our sincere appreciation to the authors for their time and effort.

Let's start with a selective and -admittedly-simplified historical perspective on How to Approach the Heart. It was Werner Forßmann in 1929 who performed the first right heart catheterization in a human being - himself [1]. While Forßmann's approach to the heart in itself was heroic, and ultimately led him to receive the Nobel prize in 1956 (together with André Cournand and Dickenson Richards), his endurance in pursuing the studies and publishing his findings reveals a great deal about what can be achieved despite unreasonable disbelief and obstruction. Forßmann's saga reminds us to cultivate optimism and to persevere [2].

"I considered a new method to approach the heart in a less dangerous fashion, namely the catheterization of the right heart from the venous system. Experiments on a cadaver were productive (...). I next undertook experiments on a living subject, namely on myself."

Werner Forßmann, 1929

Prior to the introduction of the heart-lung machine and cardiopulmonary bypass, patients with complex CHD had a very limited life expectancy because efficient therapies were lacking. More than 50 years ago then, the first patient with CHD (atrial septal defect) successfully underwent cardiopulmonary bypass and cardiac surgery at the Mayo Clinic [3]. Since then, diagnostic tools, surgical techniques, perfusion strategies and postoperative critical care have been advanced profoundly by many in the field. Today, even complex surgical procedures can be carried out with low mortality and good hemodynamic results in established CHD centers around the world, thereby allowing the majority of patients with corrected or palliated CHD to reach adulthood.

Because of these historic advances in the treatment of CHD, nowadays, pediatric and adult cardiologists are faced with the challenge of a new patient group - the adult survivors, so-called "grown-up's with CHD" (abbrev: GUCH or ACHD). In this issue, Romfh et al. outline a practical, extensively illustrated guide to the optimal management of this emerging patient group that will prove to be useful in adult cardiology follow up clinics [4]. Moreover, Baraona and co-workers - also from Stephen Sanders' group - discuss the coronary artery system, its variants and abnormalities, and the impact of the latter on the follow up of the young adult with CHD [5]. Special features and patterns of abnormalities in certain types of CHD are reviewed, and the according surgical or interventional implications emphasized. The authors also write on the current understanding and therapeutic strategies for coronary artery abnormalities in Kawasaki's disease.

Moreover, Meadows et al. discuss the recent progress that has been made in the interventional approaches to treat CHD effectively and safely, including interventional-surgical hybrid procedures [6]. The authors focus on the growing field of transcatheter implantable heart valves and other newly developed devices as well as new targets and improved techniques for angioplasty and valvuloplasty. Patent ductus arteriosus (PDA) persisting beyond infancy has been the first cardiovascular abnormality that routinely was treated interventionally [7]. Still, advances are being made in the development of improved devices both for closing the Ductus arteriosus, or keeping it open, e.g. in duct-dependent CHD. Moreover, our understanding of the pathobiology of the (persistently patent) DA is thriving. New genetic and mechanistic aspects of ductus arteriosus in infancy and beyond, and possible therapeutic implications are presented and discussed by Stoller et al. [8].

Three of the review articles in this special issue deal with the rapidly growing number of innovative imaging techniques for CHD which continue to gain quality, practicability and clinical relevance. Steinmetz et al. report the current state of knowledge in cardiac magnetic resonance imaging in CHD with special emphasis on the evaluation of ventricular function and further improvements in real-time MR imaging [9]. In their article, Koestenberger et al. comprehensively summarize recent innovations in transthoracic echocardiography [10]. These include a variety of newly established modalities such as tissue tracking and improved PW/CW Doppler and tissue Doppler techniques that enable better non-invasive documentation and understanding of the underlying pathophysiology in CHD. Furthermore, Hornberger et

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al. focus their review on fetal echocardiography including the current state of prenatal cardiovascular interventions, their limitations and future directions [11].

In recent years, the importance of the right ventricle for cardiac performance, especially in CHD, has attracted more attention because of its relevance for the prognosis and well-being of patients with either single or biventricular circulations. Guilhaire et al. give a thorough overview of the most important mechanisms involved in deterioration and remodeling of the right ventricle and discuss therapeutic strategies to improve right ventricular performance [12].

As is applicable for many aspects discussed in this special issue, new insights into the role of genetics (and more recently – epigenetics) has profoundly changed and broadened our knowledge and understanding of CHD development, as reported by Ware et al. [13]. In addition, the field of pulmonary vascular disease (PVD) and pediatric pulmonary hypertension is enlightened more clinically by Gorenflo et al. [14] whereas Rajabali et al. describe novel insights into the role of stem cells and progenitor cells in the pathobiology of PVD [15].

Taken together, congenital heart disease - despite its heterogeneous nature - is probably one of the most rapidly developing fields among all subspecialties in cardiology, if not in clinical medicine. Through innovate basic and clinical research on CHD, great progress has been made both in the refinement of diagnostic tools and treatment. With the contributions of a wonderful group of clinicians and scientists co-authoring the 11 papers of this JCEC special issue, we hope to have gathered a collection of articles that will be of great interest to the journal's readership.

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