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Advances in Pediatric Cardiology: Diagnosis and Management of Congenital and Acquired Heart Diseases in Children

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Abstract

Pediatric cardiology focuses on diagnosing and treating congenital and acquired cardiovascular diseases in infants, children, and adolescents. With improvements in prenatal diagnostics, surgical interventions, and catheter-based therapies, the prognosis for many pediatric cardiac conditions has significantly improved. This article reviews major congenital heart defects (CHDs), discusses recent advances in diagnostic imaging, explores interventional cardiology approaches, and highlights long-term management strategies. Special attention is given to the role of genetics, early screening programs, and multidisciplinary care in improving clinical outcomes for pediatric cardiac patients.

Keywords: Pediatric cardiology; Congenital heart disease; Echocardiography; Cardiac catheterization; Heart failure in children; Tetralogy of Fallot; Atrial septal defect; Ventricular septal defect; Pediatric arrhythmia; Cardiac surgery

Introduction

Congenital heart defects (CHDs) are the most common type of birth defect, affecting approximately 1% of live births globally [1]. Pediatric cardiology encompasses a broad range of conditions, from simple defects like atrial septal defects (ASDs) to complex cyanotic anomalies such as Tetralogy of Fallot. Early identification, precise diagnosis, and timely intervention are crucial to optimizing outcomes. With recent advances in fetal echocardiography, catheter-based interventions, and surgical techniques, survival rates have improved dramatically over the last few decades [2].

Description

Pediatric cardiac disorders are categorized into congenital and acquired types. Common CHDs include ventricular septal defect (VSD), ASD, patent ductus arteriosus (PDA), coarctation of the aorta, transposition of the great arteries (TGA), and Tetralogy of Fallot [3]. Acquired cardiac conditions, though less common, include rheumatic heart disease, myocarditis, Kawasaki disease, and cardiomyopathies [4].

Echocardiography remains the cornerstone of non-invasive diagnosis. It provides real-time anatomical and functional assessment and is often complemented by cardiac MRI or CT in complex cases [5]. Fetal echocardiography allows prenatal diagnosis from 18 to 22 weeks of gestation, enabling delivery planning and immediate postnatal management [6].

Cardiac catheterization and interventional cardiology have revolutionized pediatric cardiac care. Procedures such as device closure of ASDs and PDAs, balloon valvuloplasty, and stent placement are now routinely performed, reducing the need for open-heart surgery in many cases [7].

Pediatric arrhythmias, including supraventricular tachycardia (SVT) and complete heart block, are also managed within this specialty. Electrophysiological studies and ablation therapy are effective in selected cases, especially for drug-refractory SVT [8].

Results

Surgical survival for most major CHDs now exceeds 90% in specialized centers [9]. For instance, outcomes following surgical correction of Tetralogy of Fallot or arterial switch operations for TGA are excellent, with increasing numbers of children surviving into adulthood. Catheter-based interventions show comparable efficacy with lower morbidity in selected simple and moderate CHDs. Long-term follow-up studies reveal that while many children live healthy lives, a significant proportion require reintervention or exhibit long-term sequelae such as arrhythmias or reduced exercise tolerance [10].

Discussion

Multidisciplinary care involving pediatric cardiologists, cardiac surgeons, intensivists, geneticists, and psychosocial teams is essential for managing complex CHDs. The psychosocial impact on families, especially in cases requiring multiple surgeries or lifelong follow-up, must be addressed through structured counseling and support systems [6].

Genetic testing is increasingly used to identify syndromic and non-syndromic causes of CHDs, such as 22q11.2 deletion syndrome in conotruncal defects. Personalized care pathways and genetic counseling play vital roles in family planning and management [7].

In developing regions, lack of early diagnosis and access to specialized care remain major barriers, contributing to preventable mortality. Pulse oximetry screening is a cost-effective strategy for early detection of critical CHDs in newborns and is being increasingly adopted worldwide [8].

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Future directions include tissue-engineered valves, hybrid procedures, machine learning–based diagnostic algorithms, and improving transition care from pediatric to adult congenital cardiology programs.

Conclusion

Pediatric cardiology has transformed from a high-mortality field to one of precision and hope, where most children with heart disease can expect a good quality of life. Continued innovation, equitable access to care, and long-term follow-up are essential to ensure these gains are sustained across all populations.

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