Pediatric Cardiology
https://doi.org/10.1007/s00246-022-02957-2

REVIEW

From Other Journals: A Review of Recent Articles by Our Editorial Team

Kamel Shibbani[1] · Tarek Alsaied[2,3] · Awais Ashfaq[4]

Received: 10 June 2022 / Accepted: 13 June 2022

In this review we provide a brief description of recently published articles addressing topics relevant to pediatric cardiologists. Our hope is to provide a summary of the latest articles published in other journals in our field.

1. Cardiovascular Outcomes in Collegiate Athletes After SARS-CoV-2 Infection: 1-year Follow Up From The Outcomes Registry For Cardiac Conditions in Athletes. Moulson, N, Petek, B. J, Drezner, J. A, Harmon, K. G, Kliethermes, S. A, Patel, M. R, Baggish, A. L, Circulation; 2021; 144 (4) [1].

The ramifications of SARS-CoV-2 infection on the cardiovascular health of collegiate athletes has been the subject of several studies. This study provided more insight into this question by assessing cardiovascular outcomes in collegiate athletes with confirmed SARS-CoV-2 infection. Subjects were included if they are collegiate athletes with confirmed SARS-CoV-2 infection and with documented follow-up to determine cardiovascular outcome. Adverse cardiovascular outcomes were defined as one of the follows: heart failure, new significant arrhythmia, sudden cardiac arrest, or death. Participants were followed over a period of 13 months in this prospective, observational, cohort study that included 5 sites that participate in the Outcomes Registry for Cardiac Conditions in Athletes registry.

Of the 3675 athletes recruited in the study, 97% underwent cardiovascular assessment that included ECG, TTE, troponin level, or cardiac MRI (CMR). Definite or probable myocarditis, pericarditis, or myopericarditis was identified in 21 patients, representing 0.6% of the cohort. All 21 athletes were cleared to return to sports after a period of restriction that ranged from one to three months. No adverse cardiovascular outcomes were identified in this subset of 21 athletes. Alternatively, of the 3654 athletes that had confirmed SARS-Cov-2 infection with no cardiac involvement, two adverse cardiovascular outcomes where identified. The first, sudden cardiac arrest with successful resuscitation, occurred > 3 months after SARS-CoV-2 infection. The second, atrial fibrillation requiring cardioversion, occurred < 2 weeks after SARS-CoV-2 infection.

Of the 21 athletes with definite or probable myocarditis, pericarditis, or myopericarditis, 10 underwent a follow-up CMR. Interestingly, 7 had complete resolution of CMR findings, 1 had partial resolution and 2 had no resolution of CMR findings.

Overall, the study shows that the prevalence of cardiac involvement in SARS-CoV-2 infected collegiate athletes is low (0.6%) which is consistent with prior studies. Importantly, this study highlights that the risk of 1-year adverse cardiovascular outcomes associated with SARS-CoV-2 infection in athletes is also low.

2. Clinical Features and Natural History or Preadolescent Nonsyndromic Hypertrophic Cardiomyopathy. Norrish G, Cleary A, Field E, Cervi E, Boleti O, Ziolkowska L, et al. JACC. 2022;79(20) [2].

Hypertrophic Cardiomyopathy (HCM) is the most common inherited monogenic cardiac disorder, with a prevalence that has historically been placed at ~ 1:500. Typically thought of as a disease of adulthood, there is now a growing recognition that pediatric patients are at risk of HCM complications, including life-threatening arrhythmic events. This study aimed at characterizing the clinical presentation and natural history of HCM in patients diagnosed at less than 12 years of age. Findings were compared to 568 patients with HCM diagnosed between 12 and 16 years of age.

This retrospective study included 639 children with HCM diagnosed at less than 12 years of age, with an almost

✉ Tarek Alsaied
tarek.alsaied84@gmail.com

[1] Department of Pediatrics, University of Iowa Children's Hospital, Iowa City, IA, USA

[2] Heart Institute, Pittsburgh Children's Hospital Medical Center, 3333 Burnet Avenue, Pittsburgh, PA 45215, USA

[3] Department of Pediatrics, University of Pittsburgh, Pittsburgh, PA, USA

[4] Heart Institute, Johns Hopkins All Children's All Children's Hospital, St. Petersburg, FL, USA

Published online: 28 June 2022

equal distribution of diagnoses in the following age groups: 1–4 years (31%), 5–8 years (32%), 9–12 years (37%). Of the patients with an identified genetic cause for HCM, *MYH7* represented the most common disease-causing gene. Approximately 11% of patients underwent myectomy, 3.4% required pacemaker placement and 23.3% required an ICD placement. A life-threatening arrhythmia was present in 10.8% of the study population. Of the entire cohort, 6.6% died during the study period of 5.6 years, with sudden cardiac death (SCD) being the most common cause of demise at 73.8% of all death. Twenty-one required a cardiac transplant, and this represented 3.3% of all patients. Factors associated with death or transplant included heart failure, enlarged left atrial size, and the absence of an identifiable genetic cause of HCM. The annual incidence of mortality or cardiac transplant was 1.41% and that of a life-threatening arrhythmia was 1.52%.

When comparing the outcomes of the study group to the outcomes of HCM patients diagnosed at 12–16 years of age, the younger group was less likely to have a family history of SCD or a history of syncope. There was no difference in degree of hypertrophy, although the younger cohort did have a higher incidence of left ventricular outflow tract obstruction (27.2% vs 16.1%). This likely contributed to the difference in myectomy, which was found to be higher in the younger group (10.5% vs 7.2%). There was no significant difference between the two groups in the rates of death or cardiac transplant, nor in the time from diagnosis to the endpoint of death or transplant. Similarly, there was no significant difference in the annual incidence of life-threatening arrhythmic events. Interestingly, a lower proportion of patients in the 1–12-year group received an ICD for primary prevention compared to the older age group. This, however, could speak to the difficulty of ICD placement in younger children as opposed to the need for ICD in one group versus the other.

This study sheds light on a highly prevalent disease that is typically thought of as being a problem in the adolescent and young adult population. Indeed, this study shows that preadolescent patients are at an equally increased risk of death and life-threatening arrhythmic events as those diagnosed at an older age. With this information in mind, pediatric cardiologists should approach HCM in the preadolescent population in a similar fashion to HCM in older patients.

3. Long-Term Outcomes After Melody Transcatheter pulmonary Valve Replacement in the US Investigational Device Exemption Trial. Jones TK, McElhinney DB, Vincent JA, Hellenbrand WE, Cheatham JP, Berman DP, et al. Long-Term Outcomes After Melody Transcatheter Pulmonary Valve Replacement in the US Investigational Device Exemption Trial. Circ Cardiovasc Interv. 2022;15(1) [3].

Over the past two decades, transcatheter pulmonary valve replacement (TPVR) has emerged as a viable alternative to surgical intervention for bioprosthetic valves and conduits. Since the first investigational device exemption (IDE) trial in 2007, the Melody valve has become one of the most utilized valves in TPVR. In this study, the authors look at long-term outcomes of the Melody valve over a period of 10 years. The study assessed outcomes in 149 patients who, at the time of valve implant, were ≥ 5 years and ≥ 30 kg and had a melody TPVR placed in a conduit of ≥ 16 mm or to replace a bioprosthetic valve of ≥ 18 to ≤ 22 mm. The primary outcome of the study was freedom from valve dysfunction (defined as freedom from surgical intervention, catheter intervention, or hemodynamic dysfunction). Secondary outcomes included rate of death.

The median age for the patient population was 19 years. Median follow-up time was 8.4 years. Of the 149 patients who were included in the study, 58 completed the 10-year follow-up assessment. Freedom from hemodynamic dysfunction (defined as moderate or severe regurgitation, or a mean RVOT gradient > 40 mmHg) was 53% with younger age at implant representing a risk for shorter time to dysfunction. At 10 years of follow-up, 79% of patients where free from re-operation and 60% were free from any form of re-intervention (when looking only at patients who survived, the 10-year intervention-free rate drops to 55%). Several factors were associated with higher risk of re-intervention: younger age at implantation, stenosis as the primary indication for TPVR, larger number of open-heart surgeries prior to TPVR, and a higher peak-to-peak gradient across the valve after implantation. Ten-year survival was 90% with 11 deaths reported (5 of those deaths were related to endocarditis). Lastly, freedom from endocarditis related to TPVR at 10 years was 81%, with an annualized rate of 2%.

This study shows that while TPVR has proven to be a game changer for patients requiring pulmonary valve replacement, this procedure is not without risk. Importantly, it shows that survival rates after Melody TPVR are high at 90% and rates of re-operation are low at approximately 20% by 10 years. However, approximately half of the patients alive by 10 years will require re-intervention, approximately half will have a dysfunctional valve, and approximately 20% will develop endocarditis. Perhaps the higher rates of valve dysfunction and need for re-intervention are not too surprising, as pediatric populations will often outgrow implanted stents/valves. This was, to some extent, reflected in the association of younger age with both valve dysfunction and re-intervention. However, the rate of endocarditis is concerning as endocarditis proved to be the leading cause of mortality in this cohort.

4. Propensity score matched analysis of cleft closure in complete atrioventricular septal defect repair. Buratto E,

Lui A, Hu T, Naima PS, Ivanov Y, d'Udekem Y, Brizard CP, Konstantinov IE. The Annals of Thoracic Surgery. 2022 May 113(5) [4]

Complete atrioventricular septal defect is typically repaired between 3 and 6 months of age with excellent early survival, and good long-term outcomes. However, there continues to be a high reoperation rate related to left atrioventricular valve (LAVV) regurgitation and left ventricular outflow tract obstruction and some authors have argued this is related to cleft closure. The authors in this study used a propensity score matched comparison analysis to investigate the impact of cleft closure on long-term outcomes. They include 455 patients over a span of 29 years at their single institution. Cleft of the LAVV was defined as the zone of apposition between superior and inferior bridging leaflets and the decision to close the cleft was at surgeons' discretion.

A total of 145 patients had cleft left open and 285 patients underwent closure. Out of these 106 patients were selected in each group for propensity score matched analysis. Median age was 3.6 months (mean, 9.6 ± 20.4 months) and median weight was 4.3 kg (mean, 4.7 ± 4.3 kg). Preoperative LAVVR was moderate in 17.1% (78 of 455), and severe in 3.7% (17 of 256). Median follow-up of patients was 5.4 years (mean, 7.6 years). All patients underwent a two-patch repair and 5.5% (25 of 455) of patients underwent a second bypass run to re-repair the valve. Intraoperative echocardiography showed moderate or greater LAVVR in 23.1% (105 of 455) patients. There was no difference between patients who had cleft closure or not (25.6% vs 24.2%, $P = 0.46$). Overall, early mortality was 2.9% (13 of 455), and overall survival was 89.8% ± 1.9% at 20 years. Early reoperation was a risk factor for mortality ($P = 0.004$). A total of 76 patients underwent reoperation at a median time of 1.6 months (mean, 2.0 ± 3.9 years), with 66 patients needing reoperations for LAVV. Freedom from reoperation was 72.3% ± 4.0% at 20 years. Freedom from LAVV reoperation was 74.1% ± 4.0% at 20 years. Preoperative severe LAVV regurgitation ($P < 0.001$) and early postoperative moderate or greater LAVV regurgitation ($P = 0.007$) were risk factors for reoperation, while trisomy 21 ($P = 0.03$) and recent era of surgery ($P = 0.02$) were protective. There were no differences in long-term survival ($P = 0.71$) or reoperation ($P = 0.26$) between the 2 groups.

The authors concluded that complete atrioventricular septal defect repairs can be achieved with low mortality and good long-term survival, although the reoperation rate remains high. Similar freedom from reoperation can be achieved with or without closure of the LAVV cleft.

5. Evolving approach in hypoplastic left heart syndrome with restrictive and intact septum. Generali T, Hermuzi A, Sajnach-Menke M, Johnson A, Crossland DS, O'Sullivan JJ, Nassar M, Hasan A, De Rita F. World J Pediatr Congenit Heart Surg. 2022 May 13(3). [5]

Presence of intact or restrictive atrial septum in neonates with hypoplastic left heart syndrome (HLHS) leads to hemodynamic compromise form left atrial hypertension in fetal life leading to increased pulmonary vascular resistance. As a result, mortality after surgical palliation in this cohort ranges between 30 and 70%. Immediate postnatal efforts are usually undertaken to decompress the left atrium usually percutaneously or sometimes surgically. The authors here report their approach for left atrial decompression (LAD) and the difference it makes in interstage and long-term results.

All babies with HLHS were included over a span of 15 years and restrictive septum was defined as < 3 mm opening and > 5 mmHg interatrial gradient by transthoracic echocardiogram. Their approach evolved from percutaneous septostomy to surgical and from 2014, a hybrid trans-atrial septal stent insertion through medial sternotomy. In the hybrid model, after stent insertion, bilateral PA bands were positioned. 12 neonates out of 67 (18%) with HLHS were included in the study and underwent LAD at a median time of 14 (0.5–31) hours after birth. Prenatal pulmonary vein flow reversal was found in 8/12 fetuses and two patients with intact septum had a levo-cardinal decompressing vein. Five patients underwent balloon septostomy that proved successful in 2 cases. Of the 3 unsuccessful cases, 2 required extra-corporeal membrane oxygenation (ECMO) support and died subsequently; one underwent hybrid trans-atrial stent implantation. Of the remaining 7 patients, 3 underwent surgical septectomy with inflow occlusion and 4 underwent hybrid trans-atrial stent implantations. Overall, 8 patients survived LAD and reached Norwood palliation with a survival of 67%. In 6 out of 8 survivors to Norwood, pulmonary blood flow was regulated via bilateral pulmonary arterial banding and Norwood-Sano procedure was then undertaken at a median time of 10 days (6–43). Three of the 8 required ECMO postoperatively. There was no hospital mortality after Norwood stage 1 palliation and interstage survival was 100%. Six patients successfully underwent Glenn operation at a median age of 6 (4–9) months, one underwent a Sano upgrade prior to Fontan and one was transplanted. Five patients have completed Fontan and, in all patients, branch pulmonary artery augmentation was needed.

Hospital survival following LAD was 67% and all the 4 deaths happened before reaching the Norwood stage 1 palliation. Median time to LAD of the 8 survivors was 1.3 h (0.5–19.5) compared to 26.5 h (6.6–30.2) of the 4 deaths ($P = 0.329$). There was no difference in survival between intact or restrictive septum variants, or between mitral stenosis and mitral atresia subtypes. The presence of an

Table 1 Summary of the studies

Author	Study summary
Petek et al.	Cardiovascular Outcomes in Collegiate Athletes After SARS-CoV-2 Infection: 1-year Follow Up From The Outcomes Registry For Cardiac Conditions in Athletes [1] 3675 athletes after definite COVID-19 infection followed for 13 months 21 patients (0.6%) had definite or probable myocarditis, pericarditis, or myopericarditis and all were cleared to play in 1–3 months Two clinical adverse events. One sudden cardiac arrest with successful resuscitation, occurred > 3 months after COVID-19. One atrial fibrillation requiring cardioversion, occurred < 2 weeks after infection The risk of adverse cardiovascular outcomes is not exacerbated by the identification of definite or probable myocarditis, pericarditis, or myopericarditis
Norrish et al.	Clinical Features and Natural History of Preadolescent Nonsyndromic Hypertrophic Cardiomyopathy (HCM) [2] 639 children < 12 years with HCM compared to 568 patients 12–16 years Followed for 5.6 years. A life-threatening arrhythmia in 10.8%, 6.6% died, 3.3% transplant Sudden cardiac death 73.8% of all death Factors associated with death or transplant included heart failure, enlarged left atrial size, and the absence of an identifiable genetic cause of HCM The annual incidence of mortality or cardiac transplant was 1.41% and that of a life-threatening arrhythmia was 1.52% The group < 12 years had higher left ventricular outflow tract gradient and higher myectomy Patients 1–12 years of age with HCM have a similar rate of death and life-threatening cardiac arrhythmia as those diagnosed between 12 and 16 years of age
Jones et al.	Long-Term Outcomes After Melody Transcatheter Pulmonary Valve Replacement in the US Investigational Device Exemption Trial [3] 149 patients who had a Melody valve 10-year survival is 90% with endocarditis being the most common cause of death 10-year re-operation free is 79% 10-year re-intervention rate in those that survived is 55% Annual incidence of endocarditis after Melody is 2% per patient-year This study confirms the excellent survival after the Melody valve implantation although endocarditis remains a concern and was the most common cause of death
Buratto et al.	Propensity Score Matched Analysis of Cleft Closure in Complete Atrioventricular Septal Defect Repair [4] 455 patients underwent repair over 30 years Early mortality was 2.9% and overall survival at 20 years was 89.8% Early reoperation was a risk factor for mortality ($P = 0.004$) Freedom from reoperation and freedom from LAVV reoperation at 20 years was 72.5% and 74.1%, respectively Preoperative severe and early postoperative moderate or greater LAVV regurgitation were risk factors for reoperation ($P = 0.007$) Propensity score matched 106 patients in each group There was no difference in long-term survival ($P = 0.71$) or reoperation ($P = 0.26$) between the two groups The authors conclude that repair of complete atrioventricular septal defect can be achieved with low mortality and good long-term survival, albeit reoperation rate is high. Freedom from reoperation is similar even when the cleft is not closed
Generali et al.	Evolving Approach in Hypoplastic Left Heart Syndrome with Restrictive and Intact Septum [5] 12 neonates required LAD at a median time of 14 h Successful balloon septostomy = 2, Unsuccessful = 3 (ECMO and died = 2, Hybrid transatrial stent = 1) Surgical septectomy with inflow occlusion = 3 Hybrid transatrial stent = 4 8 patients survived to Norwood palliation (3/8 needed ECMO postoperatively) No hospital mortality and interstage survival was 100% The authors conclude that LAD can be safely achieved and hybrid transatrial stent insertion appears to be a safe approach

ECMO extracorporeal membrane oxygenation, *LAD* left atrial decompression, *SARS-CoV-2* severe acute respiratory syndrome coronavirus 2, *COVID-19* coronavirus disease 2019

extra-cardiac LAD pathway did not influence the outcome. The authors went on to conclude that prompt postnatal.

LAD can be safely achieved with careful multidisciplinary planning and accurate antenatal diagnosis. In their experience, hybrid trans-atrial septal stent insertion appears to be a safe approach which combines the versatility of transcatheter techniques together with the effectiveness of surgical control (Table1).

Author Contributions The author summarized the recent published literature in this review.

Funding Not applicable.

Data Availability Not applicable.

Code Availability Not applicable.

Declarations

Conflict of interest Not applicable.

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent for Publication Not applicable.

References

1. Moulson N, Petek BJ, Drezner JA, Harmon KG, Kliethermes SA, Patel MR et al (2021) SARS-CoV-2 cardiac involvement in young competitive athletes. Circulation 144(4):256–266
2. Norrish G, Cleary A, Field E, Cervi E, Boleti O, Ziolkowska L et al (2022) Clinical features and natural history of preadolescent nonsyndromic hypertrophic cardiomyopathy. J Am Coll Cardiol 79(20):1986–1997
3. Jones TK, McElhinney DB, Vincent JA, Hellenbrand WE, Cheatham JP, Berman DP et al (2022) Long-term outcomes after melody transcatheter pulmonary valve replacement in the US investigational device exemption trial. Circ Cardiovasc Interv 15(1):e010852
4. Buratto E, Lui A, Hu T, Naima PS, Ivanov Y, d'Udekem Y, Brizard CP, Konstantinov IE (2022) Propensity score matched analysis of cleft closure in complete atrioventricular septal defect repair. Ann Thorac Surg 113(5):1553–1561
5. Generali T, Hermuzi A, Sajnach-Menke M, Johnson A, Crossland DS, O'Sullivan JJ, Nassar M, Hasan A, De Rita F (2022) Evolving approach in hypoplastic left heart syndrome with restrictive and intact septum. World J Pediatr Cong Heart Surg 13(3):311–320