International Journal of Community Medicine and Public Health
Ali MI et al. Int J Community Med Public Health. 2021 Feb;8(2):900-904
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20210032

Review Article

Effect of COVID-19 on congenital heart disease children: a literature review

Mahmoud Ibrahim Ali[1]*, Hisham Fayiz Alkhuzaie[2], Saleh Abbas Alhashim[3], Hadeel Abdulhameed Hassan[4], Amal Hassan Tawhari[5], Mariam Ali Al Aqili[3], Ahmad Khaled Abdulqader[6], Mohamed Sadek Hegaze[7], Saleh Mahdi Alturkistani[6], Abdulrahman Muneer Hameed[6], Aishah Ahmad Radin[8], Mlouk Bassam Shabrawishi[9], Shrouq Abdulaziz Almadani[10]

[1]Department of Pediatrics, Maternity and Children Hospital, Mecca, Saudi Arabia
[2]Department of Pediatrics, Security Forces Hospital, Mecca, Saudi Arabia
[3]College of Medicine, Medical University of Silesia, Katowice, Poland
[4]Health Education, Ibn Sina National College, Jeddah, Saudi Arabia
[5]College of Medicine, Jazan University, Jazan, Saudi Arabia
[6]College of Medicine, Ibn Sina National College, Jeddah, Saudi Arabia
[7]Department of Pediatrics, King Hamad University Hospital, Muharraq, Bahrain
[8]College of Medicine, Umm Al-Qura University, Mecca, Saudi Arabia
[9]General Physician, Primary Health Care Center, King Fahad General Hospital, Jeddah, Saudi Arabia
[10]General Physician, Ministry of Health, Medina, Saudi Arabia

Received: 27 December 2020
Accepted: 31 December 2020

***Correspondence:**
Dr. Mahmoud Ibrahim Ali,
E-mail: _hajali@outlook.com

ABSTRACT

Congenital heart diseases are the most common birth defects and have variable levels of severity. Some studies showed that CHD increases the odds of COVID-19 realted complications; however, others suggested that there is no such a correlation. Due to the aforementioned lack of evidence, we aim in this review to provide a comprehensive overview of the impact of COVID-19 infection on CHD patients. For that, an extensive literature search of Medline, Cochrane, and EMBASE databases was performed using the medical subject headings or a combination of all possible related terms. Patients diagnosed with both CHD and COVID-19 infection has reported that CHD patients, especially those with a genetic syndrome, are at high risk to develop moderate to severe symptoms. Moreover, CHD surgeries were postponed or even canceled, with a decline in overall admission days, due to hospital protocol or pateints' decisions. Also, the findings suggested that congenital heart surgeries can be safely done during the pandemic when there is case volume limitation, with the safety precautions are followed by both surgical staff and patients. In conclusion, the scarce evidence along with the variety in CHD types and their different clinical presentations; makes it hard to predict the outcomes and to manage CHD-COVID-19 co-morbid children. More studies are needed to guide management plans in this particular context.

Keywords: COVID-19, Congenital heart diseases, Impact, Effect, Surgeries

INTRODUCTION

Since December 2019, the global pandemic of the new coronavirus disease 2019 (COVID-19) has spread worldwide, firstly, it was reported in Wuhan, China, and caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2).[1] Due to the rapid rise of COVID-19 cases, hospitals were struggling to cope with the sudden high influx of the patients which had a negative impact on

other parts of health care. This led to postponing and/or reducing out-patient clinic appointments as well as elective surgeries.[2]

Although COVID-19 cases can be asymptomatic, they may have a variety of symptoms ranging from dyspnea, dry cough, and fever to multiple organ failure.[3,4] The virus can infect individuals of any age and cause symptoms, its higher severity seems to be associated with older age groups and those with co-morbidities such as hypertension, diabetes, respiratory diseases, and cardiovascular diseases (CVD).[4-7]

The COVID-19 and the cardiovascular diseases seem to have a mutual impact. Some studies showed that CVD increase both the severity and mortality of COVID-19, as well, other studies suggested that COVID-19 infection has cardiovascular complications as arrhythmia, acute myocardial infarction, and heart failure.[4,6,8] Congenital heart disease (CHD) is a term used to describe birth defects affecting the heart, which are the most common birth defects and have variable levels of severity. Some studies showed that CHD increase the complication of COVID-19 infection. However, other studies suggested that there is no correlation between COVID-19 complications and CHD.[2,5,9] Once a CHD patient is diagnosed with COVID-19 infection, the same management used to treat the general population is applied; however, these therapies have cardiovascular side effects and should be used with caution. In the same context, limited studies described the effect of COVID-19 infection on CHD children; hence, the effect of the disease on this specific population is not obvious. [10,11] Due to the aforementioned lack of evidence, we aim in this review to provide a comprehensive overview of the impact of COVID-19 infection on CHD patients.

An extensive literature search of the Medline, Cochrane, and EMBASE databases was performed on 21 November 2020 using the medical subject headings (MeSH) or a combination of all possible related terms. Studies discussing the impact of COVID-19 on congenital heart disease in children were screened for relevant data. No limits were posed on date, language, or publication type.

COVID-19 AND CONGENITAL HEART DISEASES

CHD affect about 1% of life births globally and in the last epidemics as SARS-CoV and H1N1 those patients showed worse outcomes and high mortality rates.[12] For that, the management of CHD patients and the impact of COVID-19 on them makes a challenge for the health care system.[13-15] Bertoncelli et al. outlined that the outcome of COVID-19 infection can vary according to the type of CHD. He also categorized the high-risk patients which include large ventricular septal defect (VSD), tricuspid atresia, and hypoplastic left heart syndrome. Additionally, he reported that patients who had upcoming or undergone surgeries are a high-risk group.[16]

Several studies showed cardiovascular (CV) complications as a result of COVID-19 infection in most patients; however, others reported that 88% of the included patients were not admitted to the intensive care unit (ICU).[15] In the same context, a study by Xia et al included two patients diagnosed with atrial septal defect (ASD) who had not any CV complications and was not admitted. Both were discharged after complete resolution.[17]

Impact of COVID-19 on CHD patients

A study by Lewis et al included 53 patients diagnosed with both CHD and COVID-19 infection has reported that CHD patients, especially those with a genetic syndrome, are at high risk to develop moderate to severe symptoms.[18] In the same context, a systematic review by Haiduc et al. has included concluded that CHD increases the risks of bad outcomes for patients infected with COVID-19.[15] On the contrary, an Italian multi-centre, observational cohort study that included 76 CHD patients that acquired COVID-19 infection has observed a mild clinical course of COVID-19 symptoms in CHD patients. [19] Another study included six neonates with CHD that were born to mothers diagnosed with w SARS-CoV-2 during their pregnancy showed that all six neonates were not infected or suffer from any adverse effect.[20]

Moreover, CHD surgeries were postponed or even cancelled.[2] Wojcik et al has reported that during April 2020, they had a 16% decline in operations, and all of their patients had to undergo a COVID-19 test.[21] They resumed elective surgeries with caution in May 2020 which results in a 26% increase in operations in both June and July 2020 compared to 2019.[21] Additionally, Korun et al reported in their study that there is a reduction in hospitalization days during the COVID-19 pandemic compared to the period before it. Also, their findings suggested that congenital heart surgeries can be safely done during the pandemic when there is case volume limitation, with the safety precautions are followed by both surgical staff and patients. They also recommend following the triage strategy to maintain the resources as a response to the closure of countries borders.[22]

A study had shown that the impact of COVID-19 was different on congenital heart centres based on the pattern of its spread; some of these centres had up to 39% reduction in surgical beds compared to the pre-pandemic period, while some were COVID-19 free. The surgical activity was reduced by 52% compared to 2019 and only 20% of the surgeries were elective.[23] One study has reported that 2 male patients aged 8 months and one year who had unspecified CHD suffered the most severe progression of the infection. One of them was suspected to have hereditary metabolic disease and malnutrition. Both of them developed acute respiratory distress syndrome and were admitted to ICU. Although one of them was fully recovered and discharged, the other was still hospitalized at publication time.[24]

Table 1: Overview of case reports and case series in the literature.

Ref. no.	Country	Design	Children with CHD (N)	Age and sex	CHD	COVID-19 infection outcome
30	Iran	CS	1	13 y; M	Cyanotic heart disease	Still admitted till the publication time
31	Ireland	CR	1	10 y; M	Double inlet left ventricle, pulmonary atresia, atrial septal defect, and a right aortic arch	Discharged
32	KSA	CR	1	6 w; F	Multiple ventricular septal defects and patent ductus arteriosus	Discharged
33	USA	CR	1	4 m; M	Ventricular septal defect	Discharged
34	Brazil	CR	1	35 m; F	Hypoplastic left heart syndrome	Discharged
35	USA	CS	1	3 m; M	Atrioventricular septal defect	Discharged
36	Georgia	CR	1	9 w; F	Unrepaired balanced complete atrioventricular canal defect with baseline mild to moderate common atrioventricular valve regurgitation	SARS-CoV-2 infection resolution and is doing well.
37	USA	CS	5	Pt 1: 3 m; M, Pt 2: 3 m; F, Pt 3: 6 m; M, Pt 4: 6 m; M, Pt 5: 9 m; M,	Different types of CHD	Pt 1, 3, 4: Discharged; Pt 2: Improved after complete surgical repair, remains inpatient; Pt 5: Death

CHD: congenital heart defect; F: female; M: male; Pt: patient; N/A: not available; CS: case series; CR: case report; w: weeks; m: months; y: years

The cost of medical and surgical management of CHD is very expensive and needs high-quality care which is not available for most low to middle-income countries. This is led to high mortality rates. Some international charities are working on this problem and are trying to provide critical cardiac services to the children in those countries. The COVID-19 pandemic had compromised the activities of these charities which in turn affected the mortality rates of CHD patients.[25,26] Moreover, the pandemic does not affect international surgical activity only, but also, affects surgical activity in the same country. As reported by El-Saiedi et al that people have stopped seeking medical care nationally due to the national lockdown and fear of infection, cardiac surgeries were cancelled especially those which are dependent on foreign medical help as a result of travel restrictions. Additionally, the Critical care of the neonates diagnosed with CHD was directed to emergency services to maintain isolation and/or negative-pressure rooms vacant for COVID-19 patients.[27]

A study that included 220 parents of CHD patients and children diagnosed with CHD showed that both were worried due to the lack of pediatric information and guidance, and were disappointed with the adult information available.[28] Also, the physical activity of CHD children was reduced compared to 2019 and the era before the COVID-19 pandemic and if this persists, it will affect their health.[29]

OVERVIEW OF CASE REPORTS IN THE LITERATURE

Four case-reports which collectively had four patients with different CHD reported no cardiovascular (CV) complications, although two patients were admitted to the ICU. At the last follow up point, three patients were discharged and one was still hospitalized.[30-33] Bezerra et al reported that one female patient was diagnosed with COVID-19 infection after a Fontan procedure for hypoplastic left heart syndrome. Despite the patient was admitted to the ICU and experiencing multiple pulmonary combined with other complications, she was fully recovered and discharged.[34] A case report that included a 3 year old down male patient with an atrioventricular septal defect has shown that the patient suffered from pulmonary consolidation and pneumonia. The patient's lab results showed an elevated erythrocyte sedimentation rate, C-reactive protein, and D-dimers while his complete blood count, serum ferritin, and serum procalcitonin were normal. The patient was discharged after a full recovery and did not have CV complications (Table 1).[35]

FUTURE IMPLICATIONS

During the COVID-19 pandemic, CHD patients faced a hard time as their out-patient clinic appointments and/or surgeries were cancelled or postponed, and this affects their quality of life. Additionally, the available data about

this pandemic is from the adult population and a few limited cases were reported about children and to lesser extent CHD patients. So, we need more large-scale studies about CHD children and the effect of COVID-19 infection on them; in specific, post-operative studies with an appropriate follow-up duration are highly recommended to have established guidelines about treating this special group of patients. Moreover, there should be a crisis management plan to deal with these patients in times of pandemics. Furthermore, the admission criteria of CHD children should be modified to be stricter, to avoid possible transmission of COVID-19 from the infected patients within the same hospital. Whenever necessary, the admission of CHD patients should be in separate words or with extreme infection control measures to avoid the hazards of this potentially lethal combination.

CONCLUSION

CHD patients are more susceptible to develop COVID-19 complications. Although pediatric patients are less susceptible to acquire COVID-19 infection, CHD children are more likely to develop more complications. The variety in CHD types and their different clinical presentations makes it hard to predict the outcomes and to manage CHD-COVID-19 co-morbid children. More studies are needed to guide management plans in this particular context.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med. 2020 Feb 20;382(8):727-33.
2. Radke RM, Frenzel T, Baumgartner H, Diller GP. Adult congenital heart disease and the COVID-19 pandemic. Heart. 2020;106(17):1302-9.
3. Zu ZY, Jiang MD, Xu PP. Coronavirus Disease 2019 (COVID-19): A Perspective from China. Radiol. 2020;296(2):E15-25.
4. Shi Y, Wang G, Cai X-P. An overview of COVID-19. J Zhejiang Univ Sci. 2020;21(5):343-60.
5. Gallego P, Ruperti-Repilado FJ, Schwerzmann M. Adults with congenital heart disease during the coronavirus disease 2019 (COVID-19) pandemic: are they at risk?. Rev Esp Cardiol. 2020;73(10):795-8.
6. Alsaied T, Aboulhosn JA, Cotts TB. Coronavirus Disease 2019 (COVID-19) Pandemic implications in pediatric and adult congenital heart disease. J Am Heart Assoc. 2020;9(12):e017224.
7. Guan WJ, Liang WH, Zhao Y. Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. Eur Resp J. 2020;55(5).
8. Guzik TJ, Mohiddin SA, Dimarco A. COVID-19 and the cardiovascular system: implications for risk assessment, diagnosis, and treatment options. Cardiovasc Res. 2020;116(10):1666-87.
9. Brida M, Chessa M, Gu H, Gatzoulis MA. The globe on the spotlight: Coronavirus disease 2019 (Covid-19). Int J Cardiol. 2020;310:170-2.
10. Giordano R, Cantinotti M. Congenital heart disease in the era of COVID-19 pandemic. Gen Thorac Cardiovasc Surg. 2020:1-3.
11. Stephens EH, Dearani JA, Guleserian KJ. COVID-19: Crisis management in congenital heart surgery. Ann Thorac Surg. 2020;110(2):701-6.
12. Wu W, He J, Shao X. Incidence and mortality trend of congenital heart disease at the global, regional, and national level, 1990-2017. Medicine. 2020;99 (23):e20593.
13. Yu CM, Wong RSM, Wu EB. Cardiovascular complications of severe acute respiratory syndrome. Postgrad Med J. 2006;82(964):140-4.
14. Gilca R, De Serres G, Boulianne N. Risk factors for hospitalization and severe outcomes of 2009 pandemic H1N1 influenza in Quebec, Canada. Influenza Other Respir Viruses. 2011;5(4):247-55.
15. Haiduc AA, Ogunjimi M, Shammus R. COVID-19 and congenital heart disease: an insight of pathophysiology and associated risks. Cardiol young. 2020:1-8.
16. Bertoncelli D, Guidarini M, Della Greca A, Ratti C, Falcinella F, Iovane B, Dutto ML, Caffarelli C, Tchana B. COVID19: potential cardiovascular issues in pediatric patients. Acta Biomed. 2020;91(2):177-83.
17. Xia W, Shao J, Guo Y, Peng X, Li Z, Hu D. Clinical and CT features in pediatric patients with COVID-19 infection: Different points from adults. Pediatr Pulmonol. 2020;55(5):1169-74.
18. Lewis MJ, Anderson BR, Fremed M, et al. The Impact of coronavirus disease 2019 (covid-19) on patients with congenital heart disease across the lifespan: the experience of an academic congenital heart disease center in New York city. J Am Heart Assoc. 2020:e017580.
19. Sabatino J, Ferrero P, Chessa M. COVID-19 and Congenital heart disease: results from a nationwide survey. J Clin Med. 2020;9(6).
20. Goldshtrom N, Vargas D, Vasquez A, Kim F, Desai K, Turner ME, et al. Neonates With Complex Cardiac Malformation and Congenital Diaphragmatic Hernia Born to SARS-CoV-2 Positive Women-A Single Center Experience. World J Pediatr Congenit Heart Surg. 2020;11(6):697-703.
21. Wojcik BM, Rajab TK, Newman S, Jaggers J, Mitchell MB. COVID-19 testing, surgical prioritization, and reactivation in a congenital cardiac surgery program. World J Pediatr Congen Heart Surg. 2020:2150135120967012.
22. Korun O, Yurdakök O, Arslan A, Çiçek M, Selçuk A, Kılıç Y, Altın F, Şaşmazel A, Aydemir NA. The impact of COVID-19 pandemic on congenital heart

surgery practice: An alarming change in demographics. J Card Surg. 2020;35(11):2908-12.
23. Giamberti A, Varrica A, Agati S. Impact of the coronavirus disease 2019 (COVID-19) pandemic on the Italian congenital cardiac surgery system: a national survey. Eur J Cardio-Thorac Surg. 2020;58 (6):1254-60.
24. Zheng F, Liao C, Fan Q-H. Clinical characteristics of children with coronavirus disease 2019 in Hubei, China. Curr Med Sci. 2020;40(2):275-80.
25. Bernier PL, Stefanescu A, Samoukovic G, Tchervenkov CI. The challenge of congenital heart disease worldwide: epidemiologic and demographic facts. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu. 2010;13(1):26-34.
26. Hubbard R, Latham GJ, Zabala LM, Gautam NK. The COVID-19 Crisis and its impact on congenital cardiac surgery charitable endeavors. Paediatr Anaesth. 2020;30(8):956-7.
27. El-Saiedi SA, Haeffele C, Hanna BM, Lui GK. The hidden victims of the COVID-19 pandemic: congenital heart disease patients. JACC Case Rep. 2020;2(9):1411-3.
28. Marino L, Wagland R, Culliford D, Bharucha T, Sodergren S, Darlington A-S. No official help is available - experience of parents and children with congenital heart disease during COVID-19. MedRxiv. 2020.
29. Hemphill NM, Kuan MTY, Harris KC. Reduced physical activity during COVID-19 pandemic in children with congenital heart disease. Can J Cardiol. 2020;36(7):1130-4.
30. Eghbali A, Shokrollahi S, Mahdavi NS, Mahdavi SA, Dabbagh A. COVID-19 in pediatric patients: A case series. J Cell Amp. 2020;5(1):3-5.
31. Linnane N, Cox DW, James A. A case of COVID-19 in a patient with a univentricular heart post total cavopulmonary connection (Fontan) surgery. Cardiol Young. 2020;30(9):1350-2.
32. Elbehery M, Munshi FA, Alzahrani A, Bakhsh M, Alariefy M. COVID-19 in an intrauterine growth restriction (iugr) infant with congenital heart disease: case report and literature review. Cureus. 2020;12(9): e10294.
33. Kohli U, Rosebush JC, Orlov NM, Ghavam A. COVID-19 pneumonia in an infant with a hemodynamically significant ventricular septal defect. Cardiol Young. 2020:1-3.
34. Bezerra RF, Franchi SM, Khader H, Castro RM, Liguori GR, da Fonseca da Silva L, et al. COVID-19 as a confounding factor in a child submitted to staged surgical palliation of hypoplastic left heart syndrome: One of the first reports of SARS-CoV-2 infection in patients with congenital heart disease. J Thorac Cardiovasc Surg. 2020;S0022-5223(20):31317-9.
35. Krishnan US, Krishnan SS, Jain S. SARS-CoV-2 infection in patients with down syndrome, congenital heart disease, and pulmonary hypertension: is down syndrome a risk factor?. J Pediatr. 2020;225:246-8.
36. Rodriguez Z, Shane AL, Verkerke H, et al. COVID-19 convalescent plasma clears SARS-CoV-2 refractory to remdesivir in an infant with congenital heart disease. Blood advances. 2020;4(18):4278-4281.
37. Simpson M, Collins C, Nash DB, Panesar LE, Oster ME. Coronavirus Disease 2019 Infection in Children with Pre-Existing Heart Disease. J Pediatr. 2020;227: 302-7.

Cite this article as: Ali MI, Alkhuzaie HF, Alhashim SA, Hassan HA, Tawhari AH, Abdulqader AK, et al. Effect of COVID-19 on congenital heart disease children: a literature review. Int J Community Med Public Health 2021;8:900-4.