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

Mahmoud Ibrahim Ali1, Hisham Fayiz Alkhuzaie2, Saleh Abbas Alhashim3, Hadeel Abdulhameed Hassan4, Amal Hassan Tawhari5, Mariam Ali Al Aqili6, Ahmad Khaled Abdulqader6, Mohamed Sadek Hegaze7, Saleh Mahdi Alturkistani6, Abdulrahman Muneer Hameed6, Aishah Ahmad Radin8, Mlouk Bassam Shabrawishi9, Shrouq Abdulaziz Almadani10

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.²,³ 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.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.¹³,¹⁴ 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.¹⁵

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-19.¹⁹ 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.²⁰ 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 Wójcik 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 complications and CHD increase both the severity and mortality of COVID-19.²⁴

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
The national lockdown and the COVID-19 pandemic had compromised the activities of these charities which in turn affected the mortality rates of CHD patients.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{29}

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

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

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

**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.\textsuperscript{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.\textsuperscript{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).\textsuperscript{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**
