

ORIGINAL ARTICLE

Congenital heart disease does not entail an increased risk for severe COVID-19

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Abstract

Aim: To analyse the risk of developing serious disease or death due to COVID-19 among patients who underwent heart surgery during childhood.

Methods: A retrospective combined register and patient file study. We identified all individuals who had undergone surgery for congenital heart disease in childhood between 1994 and 2019 in our Local Surgical Register that covers half of the Swedish population. This effort was cross-tabulated with the diagnosis of COVID-19 entered in the National Register of Diagnoses in Sweden from 1 March 2020 to 1 March 2021. Severe disease was defined as treatment at an intensive care unit (ICU).

Results: We identified 3950 individuals, and the median age at follow-up was 16 years (1–44). A total of 32 patients were diagnosed with COVID-19. Five of them were hospitalised for more than 2 days (5–32 days). Two adults required treatment at an ICU; both had additional comorbidity and one died. The corresponding number of ICU stays for this age range in Sweden was 2020 approximately 0.13/1000 person-years, reported from The Swedish Intensive Care Registry.

Conclusions: There was no increased rate of severe COVID-19 among individuals who had undergone surgery for congenital heart disease in childhood. Additional comorbidity is related to outcome.

KEYWORDS

congenital heart disease, COVID-19

1 | INTRODUCTION

The COVID-19 pandemic has changed the world since its start in early 2020, including at least 6 million deaths and 500 million cases (World Health Organisation). In terms of the risk factors for death and serious illness, heart-related conditions were among the first to be identified. For children and young adults with congenital heart

disease (CHD), reports regarding an increased risk of severe disease have been contradictory.^{1–3} The American Heart Association considered it likely that this patient group would become increasingly affected and have more grave outcomes due to comorbidities and compromised health.¹ The objective of this study was to determine whether patients who had undergone surgery for CHD in childhood were at risk for developing serious disease or death due to COVID-19.

Abbreviations: ASD, atrial septal defect; AS, aortic stenosis; AVSD, atrioventricular septal defect; CHD, congenital heart disease; CoA, coarctatio; DORV, double outlet of the right ventricle; F, female; IAA, interrupted aortic arch; ICU, intensive care unit; JRA, juvenile rheumatoid arthritis; PDA, patent arterial duct; PAIVS, pulmonary atresia with intact ventricular septum; PAVSD, pulmonary atresia and ventricular septal defect; M, male; NYHA, New York Heart Association Functional Classification; VSD, ventricular septum defect; TAPVD, total anomalous pulmonary venous drainage; TA, truncus arteriosus; TCPC, total cavopulmonary connection; TOF, tetralogy of Fallot.

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2 | PATIENTS AND METHODS

A retrospective study was conducted, including all individuals with surgery for CHD between 1993 and 2018 during childhood, in Gothenburg, a tertiary centre. The paediatric cardiology department at Queen Silvia Children's Hospital provides cardiac surgery for up to 5 million inhabitants. We compared our Local Surgical Register with the incidence of COVID-19-related disease entered in the National Register of Diagnoses in Sweden between 1 March 2020 and 1 March 2021. We broke heart defects down into three groups 1. Simple defects, 2. Moderate defects and 3. Complex defects. Simple defects included surgery for atrial septal defects (ASD), ventricular septal defects (VSD) and persistent arterial duct (PDA). Moderate defects included those with life-long follow-up, such as atrioventricular defects (AVSD), pulmonary and aortic stenoses, Tetralogy of Fallot, coarctation of the aorta and transposition of the great arteries. Complex defects were defined as those with univentricular circulation and pulmonary atresia with ventricular septal defects. Moderately severe COVID-19 was defined as hospitalisation for more than 2 days. Severe disease was defined as treatment at an intensive care unit (ICU). Medical reports were reviewed for subjects with reported COVID-19.

3 | RESULTS

A total of 3950 patients (individuals) were identified through the Local Surgical Register. We excluded surgery with PDA closure in babies born preterm or vascular insertion of a pacemaker. The median age in 2021 was 16 years (1–44), and 2176 were male (55%). Altogether, 2312 were 1–18 years of age during the observed study period. A total of 974/3950 (25%) patients had undergone surgery before 2 weeks of age, 1650/3950 (42%) between 2 weeks and 1 year of age, and 1326/3950 (33%) between 1 and 18 years of age. Simple defects were found in 1391/3950 (35%). Moderate defects were found in 2141/3950 (54%) and 11% (418/3950) had complicated defects. A total of 32 patients had reported COVID-19 according to the National Register of Diagnoses. Altogether, 14 were registered at outpatient care, median age of 20 (5–28). See [Table 1](#). A total of 18 subjects were registered as hospitalised. In four cases, the diagnosis was made when the patient arrived at the hospital for planned surgery, all were asymptomatic. The heart defects in these patients were hypoplastic left heart syndrome (age 2), atrioventricular septal defect and Down's Syndrome (age 2), pulmonary atresia with ventricular septal defect and 22q11 (age 4), and ventricular septal defect (age 37). A total of 14 patients were admitted to hospital with symptoms of COVID-19 at a median age of 24 years (11–37), 5 younger than 18 years, 0.21% (5/2312). Altogether, 5 were hospitalised for more than 2 days (5–32 days), see [Tables 2 and 3](#). Two patients, both born with an atrial septal defect, one with microcephaly and one with a chromosome defect, 22q11, required treatment at an ICU. The patient with a chromosome defect, who needed gastrostomy at an ICU, died at 27 years of age of COVID-19.

Key Notes

- COVID-19 does not entail an increased risk of severe disease among individuals who have undergone surgery for CHD in childhood.
- Additional comorbidity is related to outcome.
- There is no correlation with the complexity of the heart defect.

A total of 11 of the 14 hospitalised patients had comorbidities other than a heart defect, and both ICU patients had genetic defects and intellectual disabilities.

There was no correlation between the severity of COVID-19 and the heart defect.

Vaccination for COVID-19 was not offered to these patients in Sweden during this time.

4 | DISCUSSION

Our main finding was that subjects with surgically treated congenital heart defects did not have an increased risk for severe COVID-19. Additional comorbidity, but not the complexity of the heart defect, was important.

Very few studies have been based on a population with a specific, assumed risk factor such as CHD. A study from a large centre for subjects with CHD in New York reported a low incidence of COVID-19. The risk factors for more severe disease were genetic syndromes and advanced physiological stages.² On the other hand, children and adults with congenital heart defects had worse hospital outcomes than otherwise healthy patients with COVID-19 in a large register study of individuals with congenital heart defects.³ There was no information about genetic syndromes or intellectual disabilities, though several different heart defects are often combined with those known risk factors. The various heart defects were thoroughly analysed, and there was no correlation with their complexity. A report from 58 centres around the world that treated adults with CHD concluded that the risk factors for more severe disease were pulmonary hypertension, cyanosis and functional class in accordance with NYHA III. The study group consisted of 1044 subjects with COVID-19 and CHD.⁴ A European study consisting of 104 such adults identified the risk factors of cyanosis, comorbidity and unrepaired congenital heart defects.⁵ Both of them concluded that the complexity of the congenital heart defect had no correlation with the severity of COVID-19. A nationwide study from Italy, including 72 adults and 4 children with CHD who had been hospitalised for COVID-19 found no mortality and concluded that CHD was not a risk factor for severe disease.⁶ A report from India of 94 children with CHD and COVID-19 found that 9 of the 13 patients who died had unrepaired CHD and concluded that the conditions of children were very different there than in many other countries.⁷

Patient number	Age (years)	Sex (Male/Female)	Diagnose	Comorbidity
1	5	F	AVSD/TAPVD	Down's syndrome
2	15	M	AS	none
3	16	M	PAVSD	none
4	16	M	CoA	none
5	16	F	ASD	Ehler-Danlos, JRA
6	16	F	IAA/VSD	22q11
7	20	F	TCPC	none
8	22	M	TAPVD	none
9	25	F	PAVSD	22q11
10	26	M	PAIVS	none
11	27	M	VSD	none
12	27	M	ASD	22q11
13	28	M	AVSD	none
14	28	F	TOF/TAPVD	none

TABLE 1 Subjects with congenital heart defect and COVID-19, registered at outpatient care

Abbreviations: AS, aortic stenosis; ASD, atrial septal defect; AVSD, atrioventricular septal defect; CoA, coarctatio; IAA, interrupted aortic arch; JRA, juvenile rheumatoid arthritis; PAIVS, pulmonary atresia with intact ventricular septum; PAVSD, pulmonary atresia and ventricular septal defect; TAPVD, total anomalous pulmonary venous drainage; TCPC, total cavopulmonary connection; TOF, tetralogy of Fallot; VSD, ventricular septal defect.

Patient number	Age (years)	Sex (Male/Female)	Diagnose	Comorbidity
1	11	M	PDA	Microcephaly/diplegia
2	12	M	TAPVD	ADHD
3	17	F	TOF/DORV	Down's syndrome
4	19	F	CoA	hydrocephalus
5	23	F	AVSD	Down's syndrome
6	25	M	Subaortic stenose	Cardiomyopathy
7	27	F	VSD	Treated for cancer
8	27	F	VSD	Obesity
9	32	M	TA	none

TABLE 2 Subjects with congenital heart defects treated at hospital for 1-2 days

Abbreviations: AVSD, atrioventricular septal defect; CoA, coarctatio; DORV, double outlet of the right ventricle; PDA, persistent arterial duct; TA, truncus arteriosus; TAPVD, total anomalous venous drainage; TOF, tetralogy of Fallot; VSD, ventricular septal defect.

TABLE 3 Subjects with congenital heart defects treated at hospital for more than two days

Patient number	Age (years)	Sex	Diagnose	Comorbidity	Time (days)	ICU	Result
1	13	M	TCPC	Down/plastic bronchitis	32	no	Home
2	18	M	VSD	none	6	no	Home
3	24	M	TCPC	Liver cirrhosis	5	no	Home
4	26	M	ASD	22q11	22	yeas	Home
5	27	F	ASD	Chromosome defect	14	yeas	Died

Abbreviations: ASD, atrial septal defect; F, female; M, male; TCPC, total cavopulmonary connection; VSD, ventricular septal defect.

The risk factors for severe disease were socioeconomic class and baseline when admitted to hospital. This finding illustrates the importance of considering the socioeconomic factors when analysing

large worldwide studies. The study also concluded that the complexity of CHD had no impact on severe COVID-19. Two single-centre studies from the United States reported on populations of

children (42) and adults (53) with CHD and COVID-19.^{2,8} The reported risk factors for severe disease were comorbidity and genetic syndromes. Despite the low number of hospitalisations, there was a remarkably high incidence of additional comorbidity, especially genetic defects, including Downs Syndrome. The condition in patients older than 40, as well as intellectual disabilities, are known risk factors for severe disease.⁹ In the present study, both subjects with severe COVID-19 had intellectual disabilities, though their heart defects were simple (ASD).

Our study found no correlation between the complexity of heart disease and severe COVID-19, which is consistent with all other studies.²⁻⁵ Unrepaired congenital heart defects were a risk factor in some studies.^{5,7}

There are two large register studies of children with COVID-19, one from Europe that included 804404 subjects and one from the United States with 43465.^{10,11} In the European study, a subgroup consisting of 21000 subjects displayed risk factors for more severe disease of comorbidity with cancer, diabetes, heart disease and lung disease.¹⁰ It is unclear whether syndromes and genetic comorbidity were analysed in this study. In the American study, diabetes, obesity and circulatory heart disease fell out as risk factors.¹¹ Desai reported 627 children with COVID-19, identified from a global network with 293 hospitalised subjects, including one death. Reported risk factors for severe disease were comorbidity including non-CHD and respiratory disease.¹²

We reported a hospitalisation rate of 0.21% (5/2312 children) or 2.1/1000 person year, compared with 0.13/1000 person year, aged 0–20 years in Sweden during 2021.¹³ The higher hospitalisation rate among children with CHD might be due to a greater tendency to hospitalise this patient group. The outcome defined as severe disease was not worse than in the general population. The reported rate of severe disease among subjects aged 0–19 years in the general population is 0.02/1000 person year and death occurred at a rate of 0.003/1000 person year.¹³ In our study group no child needed intensive care and nobody under 27 years of age died.

4.1 | Limitations

The study was relatively small and covered only 1 year.

5 | CONCLUSION

There was no increased rate of severe COVID-19 among individuals who had undergone surgery for CHD in childhood. Additional comorbidity but not the complexity of the heart defect impacted outcome.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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