Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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The spectrum of COVID-19 in complex adult congenital heart disease: A case series

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The coronavirus disease 2019 (COVID-19) pandemic has proven to be a significant challenge both for physicians and patients with chronic conditions. There is a continuous flow of data for patients with congenital heart disease, however resources are limited and recommendations rely mainly on expert opinion [2]. Complex adult congenital heart disease (ACHD) patients represent a highly heterogenous population with great anatomical complexity and are considered a high-risk group for complications associated with COVID-19 [1]. Herein, we present five cases of complex ACHD diagnosed with COVID-19 (Table 1). Informed consent has been obtained from each patient presented.

Cases managed in hospital

Case 1

A 35-year old male with a history of Eisenmenger syndrome in the setting of unrepaired ventricular septal defect (VSD) and atrial septal defect (ASD) was presented to the emergency department because of persistent fever and productive cough. He had already been diagnosed positive with SARS-CoV-2 infection ten days ago. Vitals at admission revealed oxygen desaturation at 74% with a baseline SO_2 at 80%, without respiratory distress. An ECG was performed and revealed the known right ventricular hypertrophy patient's pattern with no ischaemic or arrhythmic alterations. The admission laboratory tests were significant for increased LDH and CRP values, without lymphopenia and increased haemoglobin 18.9 g/dl. NT-proBNP was 108 pg/ml. A chest CT was performed and revealed extensive bilateral lesions compatible with COVID-19 (Fig. 1). The patient required oxygen therapy via a face mask (he could not tolerate nasal cannula) at 5L/min to achieve oxygen saturation 80–85%. He was started on remdesivir, dexamethasone, ampicillin/sulbactam and azithromycin. His baseline medication included bosentan and acenocoumarol, which were continued. Throughout hospitalization he was clinically stable, progressively tapered off oxygen therapy and was discharged after 7 days.

Case 2

A 28-year old male with a history of transposition of the great arteries and atrial switch operation was presented to the emergency department due to fever. Rapid antigen SARS-CoV-2 testing was positive and was later confirmed by RT-PCR testing. Arterial blood gases showed satisfactory partial pressure of oxygen 78 mmHg on air. Laboratory measurements included mildly increased CRP, LDH and d-dimer levels and reduced lymphocyte count but normal ferritin levels. BNP at admission was 275 pg/ml (baseline NT-proBNP was 636 pg/ml). A chest CT revealed small areas of ground glass opacity bilaterally and mainly in the right lower pulmonary lobe (*Figure*). An echocardiogram was performed at the COVID-19 ward and was not altered from baseline, namely a hypertrophied and dilated systemic right ventricle with moderate systolic dysfunction and severe systemic atrioventricular valve regurgitation. The patient was started on ceftriaxone, azithromycin and low molecular weight heparin and continued baseline therapy with b-blocker, sacubitril/valsartan, eplerenone and furosemide. He did not require any oxygen therapy throughout his stay. His hospitalization lasted 8 days and was discharged in a stable condition.

Cases managed at home

Three patients with complex ACHD were diagnosed with COVID-19 and were managed at home (*Table*). All patients reported fever, one patient fatigue and another sore throat. None experienced dyspnoea, chest pain or arrhythmia during the disease. They were instructed to an everyday measurement of oxygen saturation and early admission in case of deterioration. The median symptomatic duration was 6 days and all patients completed a 14-day self-isolation uneventfully.

Teleconsultation for all infected patients has been scheduled one month after the infection in order to evaluate their post-COVID clinical status.

Risk stratification and treatment considerations in complex ACHD patients with COVID-19 remain vague. However, factors such as the presence of physiologic state C and D, rather than sole anatomic complexity, seem to be of paramount importance in relation to the severity of COVID-19 disease and decreased ventricular function is linked to a longer duration of symptoms [3]. Patients with cyanotic heart disease, systemic right ventricular dysfunction and pulmonary hypertension are prone to arrhythmias and rapid clinical deterioration [4]. Ideally, these patients should be admitted in expertized ACHD centres [5]. In our case, a multidisciplinary approach, involving continuous communication

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Table 1
Characteristics of patients.

Patients	CHD diagnosis	Baseline echochardiographic indices	Symptoms	Hospital admission (Yes/No)	Treatment for COVID-19
Case 1 Male, 35	ASD and VSD, Eisenmenger syndrome	Hypertrophied RV with preserved systolic function	Dyspnoea, fever, productive cough	Yes	Dexamethasone, remdesivir, ampicillin/sulbactam, azithromycin, acenocoumarol
Case 2 Male, 28	Transposition of the great arteries, status post atrial switch operation	Hypertrophic and dilated systemic RV, moderate RV systolic dysfunction, severe systemic AV regurgitation	Fever	Yes	Ceftriaxone, azithromycin, low molecular weight heparin
Case 3 Male, 19	Congenitally corrected transposition of the great arteries, VSD, pulmonary stenosis	Mild systemic RV hypertrophy and dilation, borderline RV systolic dysfunction, mild systemic AV regurgitation	Fever	No	Symptomatic relief
Case 4 Female, 35	Double inlet left ventricle, total cavopulmonary connection	Unobstructed total cavopulmonary connection, no leaks in the fenestrated device. Single ventricle (LV) dilated with moderately impaired systolic function, mild left AV regurgitation	Fever, sore throat	No	Symptomatic relief
Case 5 Male, 26	Double outlet right ventricle, VSD, status post Damus-Kaye-Stansel operation	Unobstructed Fontan circuit, no leaks. Preserved systemic systolic function	Fever, fatigue	No	Azithromycin, Symptomatic relief

ASD: atrial septal defect, AV: atrioventricular, CHD: congenital heart disease, LV: left ventricle, NT-proBNP: N-terminal pro-brain natriuretic peptide, RV: right ventricle, VSD: ventricular septal defect, TAPSE: tricuspid annular plane systolic excursion.

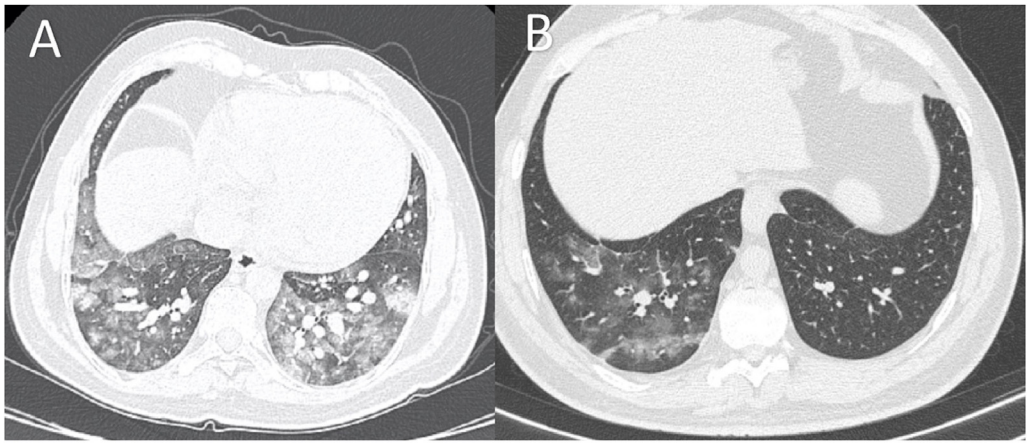

Fig. 1. A: **Case 1**. Chest high-resolution computed tomography (HRCT) findings consist of pure ground glass opacities (GGOs) and patchy consolidation surrounded by wide range of GGOs distributed in both lower lung fields. **B: Case 2**. Chest HRCT, less extended, yet similar findings are localized mainly on the right and are characterized by lower density of the lesions. In comparison with case 1, this CT image is in accordance with milder clinical course of the disease.

of attending internists and the ACHD expert, was opted for hospitalized patients. Suitably, treatment in Eisenmenger syndrome was titrated according to the baseline oxygen saturation, consistent with the elevated haemoblogin levels. Also, echocardiography, as illustrated in the second case, is not a routine as we know it and is only performed to assess deterioration in cardiac function and/or presence of pericardial effusion, and no extensive measurements are performed in order to prevent prolonged patient-echocardiographist contact. Lastly, there is no specific treatment targeting SARS-CoV-2 at the moment, therefore, hospitalized patients needing oxygen supplementation were treated mainly with remdesivir and dexamethasone [6].

There is limited amount of data as to which factors related to ACHD are prognostic for COVID-19 increased severity and is hard to predict clinical outcomes [7]. However, amidst the pandemic, the need for intensive follow-up of ACHD patients, no matter if their clinical condition is deemed stable, persists [8]. Vaccines offer hope, however the limited availability of data hinders specific recommendations. In other respects, ACHD patients should maintain a healthy, active lifestyle, maintain social distancing and utilize technology to preserve continuity of care [9,10].

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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