

Acute myocardial injury: a novel clinical pattern in children with COVID-19

Reports of coronavirus disease 2019 (COVID-19) show that children usually have mild clinical signs and less severe disease than do adults,¹ although the reasons for such differences are not yet completely understood.² A previous report³ describing paediatric COVID-19 cases in China showed that 13 (0.6%) of 2135 laboratory-confirmed and suspected cases were critical, but myocardial involvement was not noted. At the time of writing, two clinical scenarios of severe paediatric COVID-19 cases have been reported from the UK and Italy: severe shock syndrome with hyperinflammation⁴ and Kawasaki-like-disease.⁵

During March 15 to April 25, 2020, nine patients were admitted to our paediatric intensive care unit (PICU) for COVID-19; PCR tests of nasopharyngeal samples for severe acute respiratory syndrome coronavirus 2 were positive for all nine patients. Five of these patients had cardiac injury and mild to moderate cardiac dysfunction; we describe these patients in this case series. All five children (mean age 84.4 months, range 2–168) were previously healthy and had fever and gastrointestinal symptoms as initial signs at home. Three patients (1, 4, and 5) had fleeting polymorphic rash; in patient 5, the rash was associated with non-exudative conjunctivitis without involvement of the oral mucosa. Only patient 2 had respiratory distress at home requiring non-invasive mechanical support during PICU stay; none developed paediatric acute respiratory distress syndrome. On PICU admission, the main clinical signs were tachycardia and hypotension. Patient 1 was oligoanuric and patients 1, 3, and 5 had mild desaturation in spontaneous breathing in room air (SpO₂ 94–96%). Blood examinations

revealed elevated cardiac enzymes and inflammation markers. Complete demographic, clinical findings, and blood test results are shown in the appendix. All children had a mild to moderate heart dysfunction highlighted by reduced ejection fraction (mean 47.8%, SD 9.1), and all except patient 4 required a short course of intravenous epinephrine (dose range 0.05–0.1 µg/kg per min), which in patient 2 was administered with intravenous PDE3 inhibitor (milrinone 0.25 µg/kg per min).

Four children had a midbasal hypokinesia of the inferoseptal wall and inferior wall. The electrocardiogram was abnormal with non-specific changes such as sinus tachycardia, and ST and T-wave abnormalities. Patient 2 developed atrial fibrillation and had reversible acute kidney injury. Mean length of PICU stay was 3.4 days (range 1–5). All children were discharged to the ward with a normal cardiac function and good clinical conditions. Mean length of hospital stay was 7.2 days (range 5–10).

Increasing evidence shows that COVID-19 in children has different clinical patterns. Our patients did not meet all the clinical criteria for classic or incomplete Kawasaki disease because they had only one or two of the five criteria required. It is possible that this clinical picture is the mild form of the COVID-19-related shock described in the UK, which is now being labelled as paediatric multisystem inflammatory syndrome.⁶ In both cases, a hyper-inflammatory state is described with cardiac involvement mimicking atypical Kawasaki disease. COVID-19 provokes a cytokine storm;⁷ in adults it mainly compromises the lung with acute respiratory distress syndrome and affects other organs such as the heart^{8,9} to a lesser extent, which condition a higher mortality, whereas in children it seems to have a different target with a prevalent cardiac involvement. Interestingly, gastrointestinal symptoms occurred in all three groups:

seven of eight children in the UK,⁴ six of ten children in the previous case series from Italy,⁵ and all five children in our case series had diarrhoea with or without vomiting and abdominal pain. Unexpectedly, the substantial increase in cardiac enzymes (mainly NT-proBNP, which increased to up to 30 times the normal value) was not associated with severe heart failure.

Our case series reinforces the message that children with COVID-19 should be closely monitored to recognise cardiac involvement and to prevent a severe and critical course of illness.

AW, SM, GZ, AC, and VG had full access to all the data in the study and take responsibility for the integrity and the accuracy of the data analysis. All authors contributed equally in writing the paper, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work. We declare no competing interests. Verbal consent was obtained from caregivers of all five patients.

***Andrea Wolfler, Savina Mannarino, Vania Giacomet, Anna Camporesi, Gianvincenzo Zuccotti**
wolfler69@gmail.com

Division of Anesthesia and Intensive Care (AW, AC), Division of Cardiology (SM), Department of Pediatrics (VG, GZ), Children's Hospital V Buzzi, ASST FBF Sacco, Milan, Italy

- 1 Ludvigsson JF. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. *Acta Paediatr* 2020; **109**: 1088–95.
- 2 Brodin P. Why is COVID-19 so mild in children? *Acta Paediatr* 2020; **109**: 1082–83.
- 3 Dong Y, Mo X, Hu Y, et al. Epidemiology of COVID-19 among children in China. *Pediatrics* 2020; published online March 16. <https://doi.org/10.1542/peds.2020-0702>.
- 4 Riphagen S, Gomez X, Gonzalez-Martinez C, Wilkinson N, Theocharis P. Hyperinflammatory shock in children during COVID-19 pandemic. *Lancet* 2020; **395**: 1607–08.
- 5 Verdoni L, Mazza A, Gervasoni A, et al. An outbreak of severe Kawasaki-like disease at the Italian epicentre of the SARS-CoV-2 epidemic: an observational cohort study. *Lancet* 2020; published online May 13. [https://doi.org/10.1016/S0140-6736\(20\)31103-X](https://doi.org/10.1016/S0140-6736(20)31103-X).
- 6 WHO. Multisystem inflammatory syndrome in children and adolescents temporally related to COVID-19. 2020. www.who.int/news-room/commentaries/detail/multisystem-inflammatory-syndrome-in-children-and-adolescent-with-covid-19 (accessed May 16, 2020).
- 7 Mehta P, McAuley DF, Brown M, et al; COVID-19: consider cytokine storm syndromes and immunosuppression. *Lancet* 2020; **395**: 1033–34.



Lancet Child Adolesc Health 2020

Published Online

June 1, 2020

[https://doi.org/10.1016/S2352-4642\(20\)30168-1](https://doi.org/10.1016/S2352-4642(20)30168-1)

See Online for appendix

- 8 Shi S, Qin M, Shen B, et al. Association of cardiac injury with mortality in hospitalized patients with COVID-19 in Wuhan, China. *JAMA Cardiol* 2020; published online March 25. DOI:10.1001/jamacardio.2020.0950.
- 9 Guo T, Fan Y, Chen M, et al. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). *JAMA Cardiol* 2020; published online March 27. DOI:10.1001/jamacardio.2020.1017.