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Critical COVID-19 Complicating Recovery From Surgical Repair of Congenital Heart Disease

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This case highlights the need for accurate and rapid testing for severe acute respiratory syndrome coronavirus 2 and also underscores the need for caregivers to remain vigilant for coronavirus disease 2019 in the postoperative setting despite negative preoperative testing.

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Preoperative testing for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is recommended and has become routine clinical practice. We discuss an infant undergoing repair of congenital heart disease with negative preoperative testing who subsequently tested positive for SARS-CoV-2 and developed acute respiratory distress syndrome from acute novel coronavirus 2019 disease (COVID-19).

A 7-month-old boy presented for surgical repair of tetralogy of Fallot with absent pulmonary valve. Preoperative echocardiograms showed severe pulmonary stenosis, free pulmonary regurgitation, and severely dilated main and branch pulmonary arteries. The patient never displayed clinical evidence of airway compression or respiratory compromise preoperatively. There was well-balanced cardiopulmonary physiology with no hypoxia and adequate growth. A cardiac computed tomography scan confirmed the cardiac diagnosis and demonstrated compression of the distal trachea and right and left mainstem bronchi by severely dilated pulmonary arteries (Figure 1). As per our institution's standard, a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) polymerase chain reaction (PCR) assay by nasopharyngeal swab was performed 7 days before his planned surgery, and resulted negative.

Total cardiopulmonary bypass was established in routine fashion. The ventricular septal defect was closed via a right atrial incision. Both severely dilated pulmonary arteries were plicated with resection of the anterior walls. A right ventricle-to-pulmonary artery conduit (16-mm expanded polytetrafluoroethylene valved conduit)[1] was placed, and a small atrial communication was created. The cardiopulmonary bypass was discontinued without difficulty. His intraoperative transesophageal echocardiogram showed a good result with normal left ventricular systolic function, mildly impaired right ventricular systolic function, and no pulmonary stenosis.

The patient returned to the pediatric intensive care unit on inotropic support and with appropriate ventilator settings for age. He progressed as expected through postoperative day (POD) 3; supportive therapies were weaned, diuresis was ongoing, and trophic enteric feeds had been started. On POD4, he developed fever, acute oxygen desaturations, and decreased peripheral perfusion. He became significantly fluid-positive despite aggressive attempts at diuresis and had elevated central venous pressure to 20 mm Hg. Laboratory data were notable for leukopenia, thrombocytopenia, and an elevated procalcitonin at 3.9 ng/mL. Blood cultures were obtained and broad-spectrum antibiotics were empirically started. Stress dose hydrocortisone was given due to a concern for adrenal insufficiency. On POD5, he was noted to be hypothermic. Blood cultures from both peripheral and central lines grew *Streptococcus pneumoniae*, sensitive to penicillin (minimum inhibitory concentration = 1) and ceftriaxone (minimum inhibitory concentration = 0.5). Respiratory quantitative culture also grew *S. pneumoniae*. On POD6 to POD7, he had progressive third spacing and developed ascites. A peritoneal drain was placed on POD7. Echocardiogram at this time was reassuring with normal ventricular function and no pericardial effusion. He continued to have worsening in lung compliance, hypercarbia, and hypoxemia. Chest x-ray (CXR) film showed well-expanded lungs with bibasilar and right middle lobe patchy parenchymal infiltrates, which was similar to prior films. He was placed on venovenous extracorporeal membrane oxygenation (ECMO) on POD8. On POD9, a PCR test by nasopharyngeal swab for SARS-CoV-2 resulted positive.

The patient's mother and grandmother both also subsequently tested positive for SARS-CoV-2 by PCR; the mother recalled having dizziness and fever on the day of surgery and also reported having anosmia and loss of

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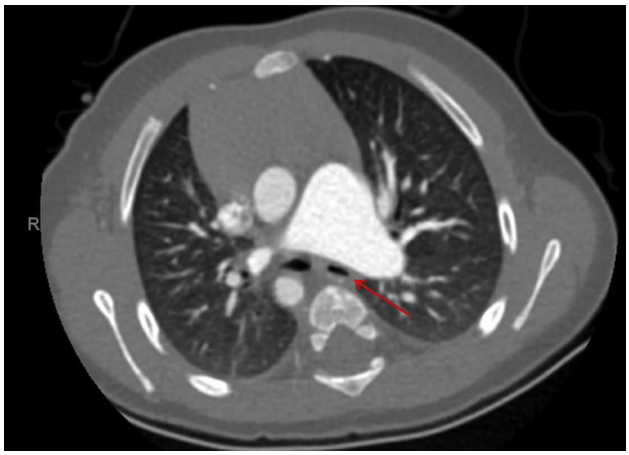

FIGURE 1 Computed tomography scan showing severely dilated branch pulmonary arteries and compression of airways (arrow).

taste. CXR film showed "white out" of the left lung, as is commonly seen in acute respiratory distress syndrome (ARDS) supported by ECMO (Figure 2).[2] The ECMO cannula was confirmed to be in good position by echocardiogram. The patient was treated with a 10-day course of remdesivir and dexamethasone guided by the pediatric infectious disease consultant. He was also treated for 6 weeks with intravenous ceftriaxone for possible pneumococcal endocarditis. Over time, his CXR film and respiratory function improved on ECMO and continuous renal replacement therapy, and he was successfully decannulated from ECMO after 9 days of support (Figure 3). He was extubated to nasal cannula on POD24 and weaned to room air on POD35. He was unable to take adequate oral feedings without aspiration, and a gastrostomy tube was placed on POD44. He was discharged home on POD50.

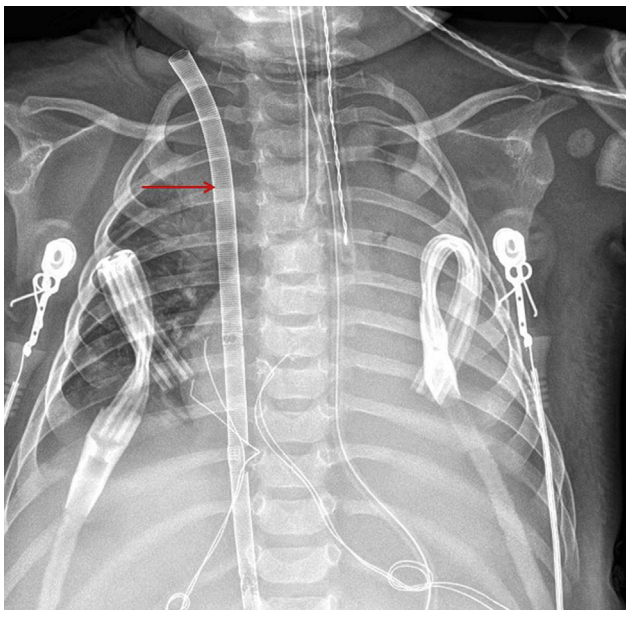

FIGURE 2 Chest radiograph on postoperative day 9. The arrow demonstrates extracorporeal membrane oxygenation cannula.

COMMENT

We report a case of an infant undergoing corrective repair of congenital heart disease whose postoperative course was complicated by acute COVID-19, pneumococcal bacteremia, and ARDS for which the patient was successfully supported with venovenous ECMO.[3] This case illuminates just one of the many new challenges in caring for children during a pandemic: unreliable preoperative testing.

While preoperative testing for SARS-CoV-2 is routinely performed, the logistics and timing appear to be problematic. Our patient likely contracted SARS-CoV-2 1 or 2 days preoperatively, and after a typical incubation period, became symptomatic approximately 5 days after infection (POD3-POD4). The source of our patient's exposure to SARS-CoV-2 remains unclear, though he most likely contracted it from his family members.

Reliable testing with rapid results needs to be ubiquitous. Additionally, preoperative testing algorithms need to be adjusted to mandate testing as close as possible to the time of the procedure in order to minimize the window of preoperative risk for infection. In our institution, testing is mandated to occur 5 days to 7 days before a procedure with patient "self-isolation" for 7 days prior. Unfortunately, complete isolation is not always possible for a child or family. This long preoperative testing time frame is fraught with risk of infection in a pediatric patient during a growing pandemic. While such risk will be impossible to completely eliminate, reducing the window for exposure is paramount.

Our case also illustrates particular clinical challenges in caring for a patient with congenital heart disease during a respiratory virus pandemic. A patient with tetralogy of Fallot with absent pulmonary valve and severe branch pulmonary artery dilation is known to have an increased risk for postoperative respiratory compromise due to congenital tracheobrochomalacia.[4] Our patient did well for 2 days to 3 days postoperatively but then quickly decompensated. The etiology of his decompensation was unclear at the time, given the presumption of negative COVID-19 status. The delayed diagnosis of SARS-CoV-2 infection led to a delay in treatment, which could have potentially curbed his inflammatory response and respiratory failure. Additionally, the delay in diagnosis exposed many hospital staff members to the virus who subsequently were required to quarantine for 14 days.

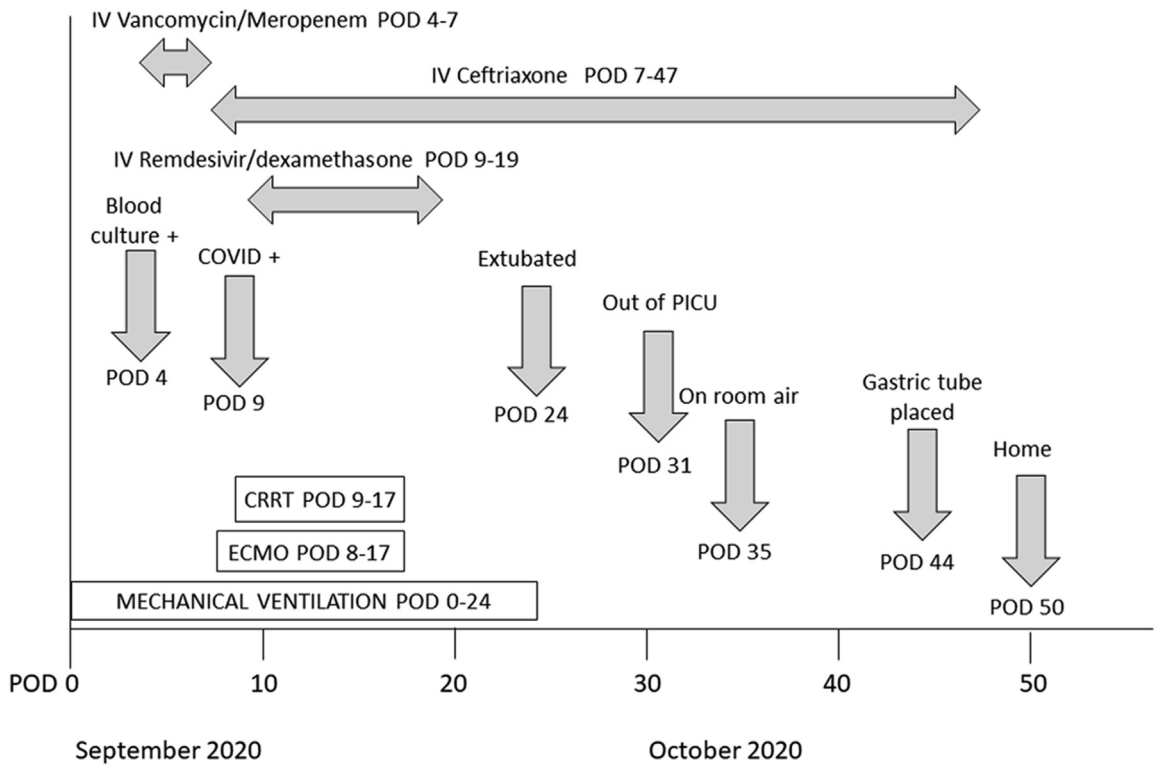

FIGURE 3 Timeline of events relative to time of surgical repair. (COVID, coronavirus disease 2019; CRRT, continuous renal replacement therapy; ECMO, extracorporeal membrane oxygenation; IV, intravenous; PICU, pediatric intensive care unit; POD, postoperative day.)

ECMO use has been previously reported to support multisystem organ failure in children with multisystem inflammatory syndrome in children associated with SARS-CoV-2.[5] Kaushik and colleagues[5] reported venoarterial ECMO utilization in a 5-year-old boy with SARS-CoV-2-associated multisystem inflammatory syndrome in children, although this patient died related to a complication from a cerebrovascular thrombus. Venovenous ECMO has also been reported to be successfully utilized for ARDS in children.[6,7] Venovenous ECMO was chosen instead of venoarterial ECMO because our patient's cardiac function had normalized after cardiac repair. Respiratory failure and ARDS were effectively supported with venovenous ECMO, and our patient has shown a remarkable recovery with a high likelihood of an excellent clinical outcome.

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