Use of CytoSorb in an infant with trisomy 21 and a complex heart defect, with septic shock and severe ARDS

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This case reports on a 7-month-old male pediatric patient (known pre-existing conditions: trisomy 21 (also known as Downs syndrome), aortic isthmus stenosis, atrioventricular septal defect (AVSD) Rastelli type C), who was admitted to the hospital for elective surgical AVSD correction.

Case presentation:

- Three days after birth (with normal weight), the child underwent primary aortic arch reconstruction with lifting-up of the descending aorta and pulmonary artery banding. Following an uneventful postoperative course, the patient was discharged home and subsequently underwent routine cardiological checks
- After elective admission, surgical AVSD correction was performed when he was 7 months old. Perioperative antibiotic therapy with cefuroxime was started
- On the 4th postoperative day, the patient was transferred to the cardiac intermediate care (IMC) ward
- After 2 days on IMC, he developed signs of progressive respiratory decompensation, resulting in transfer to the pediatric intensive care unit (PICU) followed by intubation and mechanical ventilation
- Chest X-ray indicated pneumonia and showed an atelectasis in the right upper lobe, which was subsequently confirmed and opened via bronchoscopy
- He was extubated 3 days later followed by respiratory support with a high flow nasal cannula (9 liters flow, 25-30% FiO_2)
- Discontinuation of antibiotic therapy with cefuroxime 2 days later
- The following night, the patient developed fever (40°C), along with increasing tachydyspnea and pale skin color
- Clinical diagnosis of suspected sepsis was confirmed by laboratory diagnostic findings pointing towards a generalized inflammatory response with clearly elevated inflammatory parameters as well as pancytopenia (thrombocytopenia with 45,000/µl, hemoglobin 9.9 g/dl, hematocrit 29.6%, leukocytopenia 1900/µl, Interleukin (IL)-6 >50,000 pg/ml, C-reactive protein (CRP) 8.3 mg/dl)
- Antibiotic therapy with piperacillin/tazobactam, gentamicin and vancomycin was initiated, and was then switched to meropenem, linezolid and ciprofloxacin. Due to his dramatic clinical deterioration and pending bacterial proof, antibiotic therapy was then extended to cotrimoxazole intravenously and tobramycin inhalation. In addition, the patient received pentaglobin and pentoxifylline
- Within the first 12 hours after onset of the disease, a norepinephrine infusion was started with an initial dose of 0.1 µg/kg/min, which was subsequently increased to 0.3 µg/kg/min 2 hours later. Intermittently, epinephrine with a maximum dose of 0.09 µg/kg/min was also administered following the necessity for resuscitation during intubation
- Despite all established therapeutic measures, clinical deterioration continued to progress over the next 12 hours with a concomitant development of severe acute respiratory distress syndrome (ARDS). With ventilation settings that included an FiO_2 of 100%, Pmax 35 mmHg, and PEEP 12

mmHg, only a SpO_2 of 80-84%, a paO_2 of 55 mmHg, and a $paCO_2$ of 56 mmHg could be achieved. Oxygenation index (($MAP \times FiO_2/PaO_2$) × 100) was 51, and the Horowitz index (paO_2/FiO_2) was 60 mmHg
- Due to the progressive, therapy-refractory heart-lung failure, the patient fulfilled extracorporeal membrane oxygenation (ECMO) criteria and was connected to veno-arterial (VA)-ECMO on the 3rd of his PICU stay
- Laboratory diagnostics at this time showed the following values (before start of ECMO): IL-6 643 pg/ml, CRP 42.5 mg/dl, Procalcitonin (PCT) 41.66 ng/ml, platelets 10,000/µl, lactate 4.6 mmol/l, direct bilirubin 3.8mg/dl, norepinephrine dose of 0.35 µg/kg/min and a Sequential Organ Failure Assessment (SOFA) score of 20
- Microbiological findings which became available revealed positive blood cultures for Enterobacter cloacae and a coagulase-negative Staphylococcus aureus
- Due to massive generalized edema with capillary leakage and decreasing diuresis, continuous renal replacement therapy (CRRT) was initiated in parallel with VA-ECMO
- Given the uncontrolled septic state with increased inflammatory parameters, a CytoSorb adsorber was then integrated into the CRRT circuit with the rationale to eliminate excessive plasma concentrations of these mediators

Treatment

- CytoSorb was run in combination with CRRT (Prismaflex, Gambro) in CVVHDF mode for a total of 40 hours
- Blood flow rate: 100-150 ml/min
- Anticoagulation: heparin
- Priming of the adsorber with erythrocyte concentrate/fresh frozen plasma in a ratio of 1:1
- CytoSorb adsorber position: post-hemofilter

Measurements

- Catecholamine requirements
- Inflammatory parameters
- Respiratory and ventilation parameters
- Renal function
- Lactate

Results

- Under combined treatment, catecholamines, which were required initially, could be gradually ceased. Capillary leakage also improved as shown by a regression of his massive edema
- Changes in laboratory parameters under CytoSorb therapy as follows: after 12 hours of therapy: PCT 3.39 ng/ml, CRP 10.99 mg/dl; after 36 hours of therapy: PCT 1.97 ng/ml, CRP 8.04 mg/dl; 12 hours after the end of CytoSorb therapy: CRP 5.6 mg/dl, IL-6 13.4 pg/ml, platelets 53,000/µl, direct bilirubin 1.1mg/dl
- Improvement in the respiratory situation. Adequate breathing volumes could be achieved with reduced ventilation pressures (PEEP 8 mmHg, Pmax 25 mmHg)
- Onset of diuresis (5 ml/kg/h)

- Lactate after CytoSorb discontinuation 2.2 mmol/l
- SOFA score decreased from 20 to 8 after the end of CytoSorb therapy

Patient Follow-Up

- Termination of CVVHDF simultaneously with CytoSorb hemoadsorption
- ECMO therapy was continued for another 8 days
- Successful weaning from the ventilator with extubation 10 days after ECMO discontinuation
- This was followed by 2 weeks of non-invasive respiratory support on the PICU. The patient was then transferred to the pediatric cardiology ward, from where he was discharged home after another 3 weeks

Conclusions

- A 7-month-old infant with trisomy 21 and complex heart defect, who postoperatively developed severe septic circulatory and pulmonary failure, could be successfully stabilized from a therapy-refractory shock state with VA-ECMO, CRRT and CytoSorb support
- Clinically, not only the pulmonary and hemodynamic situation improved, as evidenced by an improvement in ventilation settings and decreasing catecholamine requirements, but also the capillary leakage, which had previously led to his massive edema
- Inflammatory parameters, which still increased despite antibiotic therapy, decreased continuously during CRRT with CytoSorb
- The timely installation of the CytoSorb adsorber into the CRRT system was possible without problems during ongoing VA-ECMO use