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Successful Right Atrium-Pulmonary Artery ECMO in an Infant With Severe Necrotizing Pneumonia and Bilateral Bronchopleural Fistula

We report an infant with necrotizing pnuemonia and bilateral broncho pleural fistula, who failed on conventional and high frequency ventilation and was managed successfully on Veno-venous Extra Corporeal Membrane Oxygenator (V-V ECMO) with a unique configuration for 12 days, and weaned off successfully.

Keywords: Severe Pneumonia, Management, Ventilation.

Necrotizing pneumonia is a rare form of complicated pneumonia, which often develops secondary to organisms like *Staphylococcus aureus* and *Streptococcus pnuemoniae*. It is often difficult to manage, and occasionally develops complications like pneumothorax and broncho-pleural fistula (BPF).

An 11-month-old infant, weighing 9 kg, was referred to us for respiratory distress and fever of 3 days. He had no significant past medical history, was immunized for age and thriving well. Clinical examination revealed features of bronchopneumonia. He was started on high flow nasal cannula (HFNC) oxygen and broad-spectrum antibiotics. Investigations revealed pancytopenia with elevated inflammatory markers. His clinical condition worsened on day 3 of admission with increasing oxygen requirement (FiO_2 60%) and High flow nasal cannula (HFNC) support (flow 20L/min). He was electively ventilated and put on pressure regulated volume control (PRVC) mode of ventilation. Ventilation protocol was set to targets as suggested in Pediatric acute respiratory syndrome (pARDS) guidelines. The PaO_2 /FiO_2 (PF ratio) was less than 150 with PCO_2 <70mm Hg and PH >7.2. Initial blood culture grew *Psuedomonas* and injectable meropenam treatment was started. Prone ventilation was tried but had to be discontinued after two hours as saturations worsened. *X*-ray showed multiple large pneumatoceles**.** On day 7, he developed pneumothorax on right side; draining intercostal tube showed continuous bubbling suggesting a bronchopleural fistula (BPF). Ventilation was continued with high frequency oscillatory ventilation (HFOV). Maximum settings on HFOV were FiO_2 of 60%, mean airway pressure (MAP) of 16 cm H2O and amplitude (delta P) of 45. Child did show some improvement with improving blood gases and was maintained on neuro-paralysis. After one week on HFOV, *X*-ray showed regressing pneumatoceles with PF ratio improving to >200. $PaCO_2$ was consistently less than 60 mm Hg and PH>7.3 with HFOV settings of FiO_2 40%, MAP of 14 cm H2O and amplitude of 40. On day 13, he was weaned off paralysis and changed back to PRVC mode, but developed tension pneumothorax on left side on the next day.

Considering the child to have refractory Acute respiratory distress syndrome (ARDS) with bilateral air leak, Veno-Venous ECMO was initiated on day 15 of hospital admission. Patient's jugular vein on ultrasound was found to be small hence we decided for central open ECMO. Child was initially put on Veno–venous configuration with inflow and outflow cannulas in right atrium, but had to be re-configured in view of poor flow and re-circulation. Right atrium was cannulated with 22F cannula and pulmonary artery with 14 F cannula, and flow of 900-1000 mL/min was obtained. He was maintained on ECMO for 12 days. On day 12 of ECMO, prior to weaning a bronchoscopic clearance and lavage was taken, which showed carbapenam resistant *Acinetobacter* on culture. Antibiotics were accordingly changed to colistin and tigecycline. Post-ECMO weaning on ventilator, child did

not have air leak on either side and intercostal tubes were removed. He was successfully discharged after 55 days of hospital stay. Chest *X*-ray before discharge showed near total resolution of pneumatoceles.

The exact pathogenesis of necrotizing pneumonia is not completely understood [1,2]. Necrotic areas may give way resulting in pneumothorax or BPF. When air leak develops the ventilation often becomes challenging. Ensuring acceptable gas exchange with minimum added barotrauma from ventilation is essential. Bilateral broncho-pleural fistula has a mortality risk of 20-50% [3]. Split lung ventilation or differential lung ventilation has been described in necrotizing pneumonia with unilateral broncho-pleural fistula. Several other strategies include endobronchial plugging with human fibrin glue in small fistulas [4], autologous pleural patch, video-assissted thoracoscopic fistulectomy or stapling and pneumo-nectomy are described in selected cases [5]. Our patient had limited options, as the disease was bilateral and extensive with multiple necrotic areas. High frequency oscillatory ventilation (HFOV) is an option for refractory ARDS and air leaks who fail on conventional ventilation [6]. HFOV eliminates the 'inflation-deflation' cycle. It maintains gas exchange with very low tidal volume and optimum mean airway pressure, but this child developed pneumothorax on weaning back to conventional mode.

Veno-arterial (VA) configuration was avoided for ECMO because of higher rates of complications in infants and is not the preferred mode for respiratory failure [7,8]. ECMO cannulation mostly performed in infants is a double lumen internal jugular venous (IJV) cannulation but in our patient IJV lumen was small on screening ultrasound. We initially resorted to an open chest central cannulation with two different cannulas in right atrium. This had to be revised due to poor blood flow and significant re-circulation. We finally tried a unique but less performed, Right atrium-pulmonary artery (RA-PA) configuration to completely eliminate re-circulation.

We have not come across any reports on RA-PA configuration in small children. The main disadvantages of a central open chest ECMO are higher chances of infection and bleeding. The insertion time and bleeding from cannulation site were significantly higher than that described in literature for dual lumen IJV cannula [9]. The case highlights the importance of considering ECMO as a salvage but feasible option in selected cases of severe pnuemonia with refractory respiratory failure even in developing countries.

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