

## RESPIRATORY ADULTS

### Extracorporeal Membrane Oxygenation in a Patient with Severe ARDS in the Context of Exacerbation of Idiopathic Interstitial Pneumonia with UIP Pattern

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**Introduction:** Idiopathic interstitial pneumonia (prevalence: 70-80/100,000) is a heterogeneous disease. It typically affects the pulmonary interstitium and causes fibrosis by increasing the connective tissue. Typical symptoms are dry cough and progressive shortness of breath, which usually leads to respiratory failure. Currently, lung transplantation is the only curative therapy option for pulmonary fibrosis.

**Case Report:** We report a 54-year-old patient who originally presented in our department in 03/15 with an early stage idiopathic lung fibrosis and bronchial adenocarcinoma cT3 N0 M0. A curative therapy with resection of the left lower lobe and adjuvant chemotherapy was successfully established. In 01/16 the patient had severe dyspnea at rest. CT scan of the chest showed bilateral alveolar infiltrates, honeycomb patterns and “crazy paving”. In this threatening ventilatory failure under 60lpm nasal high-flow oxygen (oxygenation index approximately 46.7) and radiomorphologically white lung, awake vVECMO was initiated. As Pneumocystis pneumonia was suspected, therapy with co-trimoxazole and caspofungin was initiated and the patient received immunosuppression with prednisolone and azathioprine. A pathogen was not detected under antibiotics. Over time the lung recovered. The ECMO flow could be successively reduced and the ECMO was removed after a total of 43 days. Antifibrotic therapy with nintedanib was started. The patient is currently mobile under LTOT (10 lpm).

**Conclusion:** ECMO is a possible therapy as “bridge to recovery” in acute respiratory failure in interstitial pulmonary disease. The poor prognosis of the underlying disease remains unchanged without LTx.

### Extracorporeal Membrane Oxygenation (ECMO) as Salvage Treatment for Pulmonary *Echinococcus Granulosus* Infection with Acute Cyst Rupture

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**Introduction/Aim:** Extracorporeal membrane oxygenation (ECMO) has been successfully used for the treatment of patients with respiratory failure due to severe bacterial and viral infections, e.g. influenza A. Though rare, parasites can also cause severe pulmonary disease. Tapeworms of the genus *Echinococcus* give rise to the development of cystic structures in the liver, lungs and other organs. Acute cyst rupture leads to potentially life-threatening infection, and affected patients may deteriorate rapidly.

**Case report:** A 23-year-old woman from Bulgaria was admitted to hospital with severe dyspnoea, progressive chest pain and haemoptysis. The patient needed to be intubated due to severe hypoxaemia. She continued to deteriorate on mechanical ventilation. Therefore, she was cannulated for veno-venous ECMO. Computed tomography (CT) of the chest showed a large, partially ruptured cystic structure

within the left hemithorax, which was pathognomonic of cystic echinococcosis caused by *E. granulosus*. Albendazole was added to the antimicrobial regimen (meropenem and vancomycin). After seven days of ECMO support, the patient's condition improved considerably, and she was successfully weaned from both ECMO and mechanical ventilation. She underwent lobectomy of the affected left lower lobe. The patient was discharged home in good condition on oral albendazole.

**Conclusion:** This is the first report on the successful use of ECMO as salvage treatment for a severe pulmonary manifestation of a parasitic disease. Due to recent migration to Western Europe, the number of patients presenting with respiratory failure due to pulmonary echinococcosis with cyst rupture is likely to increase. This report illustrates the use of ECMO as a rescue therapy in severe and refractory cases.

### Acquired Coagulation Disorders in Extracorporeal Lung Assist: Comparison Between avECCO<sub>2</sub>R, vvECCO<sub>2</sub>R and vVECMO

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**Introduction/Aim:** Bleeding leading to transfusion is a main complication under extracorporeal lung support (ECLS). Comparative data between different devices concerning coagulation are scarce. We compared changes in hemostasis under treatment with avECCO<sub>2</sub>R, vvECCO<sub>2</sub>R and vVECMO.

**Methods:** Retrospective single center analysis (01/2005 to 05/2016), all patients treated on extracorporeal lung assist (ECLA) were included.

**Results:** 144 Patients (29 avECCO<sub>2</sub>R, 23 vvECCO<sub>2</sub>R and 94 vVECMO; mean age 50.6 ± 16.4 years, 86 male (59.7%)) were analyzed. Cases significantly increased from 2012 on. ECLS was initiated due to AECOPD in 9 cases (6.3 %), as bridge to transplant in 49 cases (34 %) and due to ARDS in 68 Cases (47.2%). Initial blood flows were 3.42 ± 1 L/min in the ECMO group, 1.30 ± 0.4 L/min in the vvECCO<sub>2</sub>R Group and 1.53 ± 1.3 L/min in the avECCO<sub>2</sub>R group. Platelets decreased from baseline to day 5; 229.7 ± 123.1 to 121 ± 65.3/μL in the ECMO group, from 253.2 ± 103 to 132.9 ± 55.8 /μL in the vvECCO<sub>2</sub> group and from 204.9 ± 89.2 to 157.3 ± 80.8/μL in the avECCO<sub>2</sub>R group. Fibrinogen decreased from 520 ± 212.9 to 404.5 ± 154.5 mg/dL in the ECMO group, from 536.4 ± 169.7 to 375.8 ± 111.9 in the vvECCO<sub>2</sub> group and from 670.3 ± 313.5 to 439.3 ± 215 in the avECCO<sub>2</sub> group.

**Conclusion:** All extracorporeal support lung support devices showed an interference with the coagulation system, consumption of thrombocytes prevailed in pump-driven systems.

### Mobilisation of Patients with Veno-Venous Extracorporeal Membrane Oxygenation (VV ECMO): A Case Series

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**Introduction/Aims:** To determine the feasibility and safety of mobilising patients with VV ECMO.

**Methods:** Patients who had VV or VV-V ECMO inserted as a bridge to lung transplantation between November 2014 and March 2017 were mobilised to maintain muscle strength and function. Cannulation configurations included dual lumen Avalon cannula, single lumen jugular-femoral cannulae, single lumen femoral-femoral cannulae and single lumen femoral-femoral-jugular cannulae. Specific mobilisation techniques included sitting on the edge of the bed, standing, cycling on a static bike, marching and walking. A team of physiotherapists, perfusionists, surgical fellows, anaesthetists and nurses participated in mobilising patients. Cardiovascular haemodynamics and ECMO parameters were monitored throughout treatment sessions.

**Results:** 8 patients undertook 26 episodes of mobilisation. 5 patients were male. 6 patients had cystic fibrosis and 2 patients had pulmonary fibrosis. All patients were fully awake and were mobilised when physiological and ECMO parameters were stable, cannulae were secure and with the multidisciplinary team present. There were no significant adverse complications in association with mobilisation. Some patients did desaturate or feel dizzy whilst mobilising but recovered with rest after rehabilitation had finished.

**Conclusion:** Mobilising patients with VV ECMO is complex given the nature of their illness, cannulation site and the large amount of equipment required. A multidisciplinary team approach should be adopted. Patient's cardiovascular and ECMO response needs to be closely monitored throughout to allow timely response in the event of patient deterioration. This study suggests that it is feasible and safe to mobilise patients with VV ECMO, regardless of cannulation configuration.

### Successful Application of Venovenous Extra Corporeal Membrane Oxygenation (ECMO) for the Management of Acute Respiratory Failure Secondary to Granulomatosis with Polyangiitis (GPA)

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**Introduction:** We applied ECMO in two patients with acute life threatening respiratory failure secondary to GPA.

**Cases:** Both patients were referred from an associated hospital with progressive acute respiratory failure not responsive to conventional therapy. A provisional diagnosis of GPA was made based on an elevated anti-PR3 titers. Combination therapy of cyclophosphamide, methylprednisolone and plasma-filtration was commenced. Venovenous ECMO-treatment was started together with the cautious use of systemic anticoagulation. To correct coagulation, plasma and fibrinogen was administered after every plasma-filtration session.

The first case involves a 69-year-old woman. In addition to the primary diagnosis this patient developed severe subcutaneous emphysema secondary to a tracheal lesion. It was decided not to surgically intervene due to the increased risk of bleeding. After six days she was extubated and two days later she was decannulated successfully. She continued to improve and was discharged home. No intervention for the trachea lesion was necessary.

The second case involves a 59-year-old woman. Her hospital stay was complicated by profuse bleeding from a chest tube that had been placed for a right-sided pneumothorax. Despite ceasing systemic anticoagulation and extensive administration of clotting factors, she continued to bleed. The bleeding was successfully treated by endovascular coiling of an intercostal artery. After 27 days she was decannulated and on day 63 she was discharged home.

**Conclusion:** Extracorporeal life support was successfully used in these two patients with GPA. Although ECMO-treatment is a highly invasive procedure with a significant risk of bleeding complications, plasma-filtration and a carefully adjusted anticoagulation plan may be lifesaving in acute respiratory failure that is refractory to mechanical ventilation.

### Venovenous Extracorporeal Membrane Oxygenation Post Cardiac Surgery

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**Introduction/Aim:** ARDS developing after cardiac surgery is a common complication, which may have devastating consequences and high mortality rate. The role of VV-ECMO for the treatment of ARDS in patients following cardiac surgery is not well described.

We aimed to analyse the outcome of patients who required VV-ECMO for the treatment of post-cardiotomy ARDS.

**Methods:** From January 2011 to July 2015, 9161 patients underwent major cardiac surgery at our institution. Six patients developed acute respiratory failure following surgical intervention and were supported with the use of VV-ECMO. Patients undergoing heart or lung transplant and pulmonary-thrombo endoarterectomy were excluded from this series.

VV-ECMO was considered if patients had potentially reversible severe respiratory failure, had failed optimal conventional intensive care management and met the eligibility criteria for the respiratory ECMO service.

**Results:** Out of 9161 patients operated, 6 patients (2 coronary revascularization and 4 cardiac valve surgery) were supported with VV-ECMO in the immediate postoperative period.

Support was initiated on average 3.4 (2–6) days after surgery and continued for 8.4 (2–22) days. One patient required conversion to veno-arterial ECMO due to low cardiac output and subsequently died of unrecoverable heart failure. One patient died of MOF, and one patient suffered a fatal stroke. Three patients (50%) were successfully weaned from VV-ECMO and eventually discharged from hospital.

**Conclusion:** VV ECMO post cardiac surgery can be considered for the treatment of post-operative respiratory failure refractory to maximal ventilator support. Reversibility of the lung pathology should influence the decision to use VV-ECMO.

### Extracorporeal Membrane Oxygenation as a Bridge to Lung Transplantation in Patients with Cystic Fibrosis

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**Introduction/Aim:** The prognosis of patients with cystic fibrosis (CF) requiring mechanical ventilation due to acute respiratory failure (ARF) is poor. Whether extracorporeal membrane oxygenation (ECMO) improves outcome in these patients remains controversial.

**Methods:** Retrospective analysis of all CF patients with ARF treated with ECMO at University Hospital of Saarland from December 2012 to July 2016.

**Results:** We identified 20 patients fulfilling the criteria above (mean age 29.1 ± 10.6 years, 6 (30%) male). Reasons for deterioration were pulmonary exacerbations in the majority of cases. All patients were primarily treated on veno-venous ECMO. Two patients ultimately received veno-arterial cannulation for severe hemodynamic impairment. 3 Patients who had previously undergone lung transplantation (LTX) suffered from chronic lung allograft dysfunction. 11 (55%) patients were enlisted to LTX on hospital admission. 6 patients (30%) received LTX evaluation and were listed on ECMO. 3 Patients were listed with high urgency status. After Lung Allocation Score (LAS) implementation in Germany (12/2011), 17 patients were listed (mean LAS 91.0 ± 4 pts). 8/17 Patients finally (47%) underwent LTX, 3/8 (37.5%) as re-LTX. Mean time on ECMO was 30.8 ± 13 days. 9 Patients (45%) died on the waiting list and 3 (15%) could be weaned from ECMO without direct transplantation.

**Conclusion:** The prognosis of CF patients treated on ECMO is limited and often depending on timely LTX. Mortality on the waiting list is still an important problem despite implementation of the LAS.

### Lobar Double Lung Transplantation in a Patient with Cystic Fibrosis after Extended ECMO-Therapy

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**Introduction:** The prognosis of cystic fibrosis (CF) patients treated on extracorporeal membrane oxygenation (ECMO) is limited and often depending on timely lung transplantation (LTX).

**Case Report:** We report the case of an 18 year old CF patient (139 cm/ 38 kg). He had pneumonia complicated by a tension pneumothorax and was hospitalized in an external hospital. After intubation and mechanical ventilation (MV), he progressed to severe ARDS and was put on ECMO. He was already treated on ECMO for 10 days when he was transferred to our center by our mobile ECMO team. After retrieval he was weaned from ECMO and MV and listed for LTX after a structured and critical review of all data. However, during the same hospital stay the patient deteriorated again, MV, extracorporeal carbon dioxide removal (ECCO<sub>2</sub>R) and finally ECMO with a double-lumen cannula were established. Being 139 cm tall, he required an offer of relatively small lungs. After a prolonged course of extracorporeal support without a donor organ offer, extended organ acceptance criteria without an upper total lung capacity (TLC) limit were set. An allograft with a TLC of 7 liter was accepted for transplantation after a course of 46 days on ECMO in total. According to the size mismatch an anatomic lobar reduction with transplantation of the left upper - and the right upper and middle lobe was performed. The patient could be weaned from ECMO 3 days and from MV 18 days later and was finally discharged home. Three month after LTX, he started to work again.

**Conclusion:** The time frame for LTX in CF patients on extracorporeal support is short. Lobar transplantation is a lifesaving option for patients who cannot wait for size matched organs.

### Use of Venovenous Extracorporeal Membrane Oxygenation for the Treatment of Viral Pneumonia-Induced Acute Respiratory Distress Syndrome

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**Introduction:** Severe pneumonia and acute respiratory distress syndrome (ARDS) can be caused by viral respiratory pathogens. Despite advances in intensive care, mortality of patients with severe ARDS remains high (68–90%). We describe our institutional experience with adult patients receiving extracorporeal membrane oxygenation (ECMO) due to viral pneumonia-induced ARDS.

**Methods:** Between April of 2011 to June of 2016, 60 patients were treated at Fundación Cardiovascular de Colombia with veno-venous ECMO, among whom 13 were treated for viral pneumonia-induced ARDS.

**Results:** 13 patients, 4 females, 9 men, media age 51±12 years (28–67), media body mass index 33±6 (26–44), hypertension 53%, diabetes 23%, COPD 7%, smokers 23%, media SOFA score at ICU admission was 9±3 (3–15). The origin of patients were: 6 international and 7 national. 11 patients required mobile ECMO: 7 by aircraft and 4 by ground ambulance, and 2 were cannulated at our institution. 7 patients were tested positive with RT-PCR (reverse-transcriptase-polymerase-chain-reaction): 6 H1N1 virus and 1 Influenza A virus. 6 patients were suspected cases of viral pneumonia due to epidemiological link. All confirmed cases were treated with Oseltamivir. The median duration of ECMO support was 20 (IQR 10–236) days. 3 patients died cannulated in ECMO. Successful ECMO weaning was 77% (10/13). After weaning, two patients died at 15 and 60 days. 8 patients (61%) were discharged alive.

**Conclusion:** ECMO may be an effective salvage treatment for patients with viral pneumonia-related ARDS, particularly when provided by a mobile team allowing early cannulation prior to transfer to a reference centre.

### Incidence and Risk Factors of Venous Thrombosis After Venovenous Extracorporeal Membrane Oxygenation in Patients with Acute Respiratory Distress Syndrome: a Prospective Observational Study

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**Introduction/Aim:** Venovenous extracorporeal membrane oxygenation (vvECMO) is indicated for refractory severe acute respiratory distress syndrome. A frequent complication of intravenous catheters is thrombosis, however little is known on the incidence after ECMO.

**Methods:** We prospectively enrolled 252 consecutive patients on vvECMO from 2010–2017 in our medical intensive care unit. 54 (21%) patients died on ECMO. Duplex sonography screening or computertomography was performed for thrombosis after decannulation in patients after weaning from ECMO. Thrombosis was classified as clinically relevant, if the vein was occluded >50% of lumen. Incidence of thrombosis was correlated with coagulation parameters (aPTT, D-Dimers, INR, fibrinogen, plasma free hemoglobin, platelets), cannula size, time on vvECMO, renal failure, and underlying malignant disease.

**Results:** Duplex sonography or computertomography was performed in 173/198 cases (87%). Any kind of thrombosis was detected in 108 cases (62%), 28% (48/173) were considered clinically relevant. Most commonly thrombosis was located in the right jugular vein 79% (85/108). In patients with clinically relevant thrombosis, proportion of days with aPTT ≤50s was higher (70% vs. 57% for no thrombosis, p=0.003). Incidence of any thrombosis was increased in patients >65years (81% vs. 59%) and in single vs. double lumen cannulas (66% vs. 42%).

**Conclusion:** The incidence of clinically significant thrombosis after vvECMO is high. Reduced systemic anticoagulation, which is increasingly suggested for modern ECMO, enhances the risk. Routine duplex sonography post ECMO should be performed to evaluate on the need for prolonged anticoagulation.

### VV ECMO is Lifesaving in H1N1 Pneumonia

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**Introduction/Aim:** Extracorporeal membrane oxygenation (ECMO) is a valuable therapeutic option for patients with acute lung failure. Patients who underwent VV ECMO because of H1N1 infection due to respiratory failure in our clinic are presented. We describe the indications, technical aspects, and outcomes of placing VV ECMO in adults using jugular and femoral veins.

**Methods:** Eight patients were documented for H1N1 pneumonia and 6 of them need Intensive Care Unit for respiratory failure. VV ECMO performed to 4 of them.

**Results:** One of the patient to whom VV ECMO not performed were die. Cases: Patient 1; 30 years old man, Patient 2; 43 years old woman, Patient 3; 59 years old woman Patient 4: 38 years old woman with no significant previous medical history presented with refractory hypoxemia after flu like symptoms. Due to progressive hypoxemia despite appropriate ventilator strategies, VV-ECMO was initiated for severe Acute Respiratory Distress Syndrome.

Patient 1: After 4 day VV-ECMO he extubated and 5th day chest X-ray become normally and he weaned from VV-ECMO at 8th day. Patient 2 was dead after the 4th day of ECMO and Patient 3 was dead after 5th day of ECMO. Patient 4: After 2 day VV-ECMO she extubated and 4th day chest X-ray become normally and she weaned from VV-ECMO at 4th day. But she died because of non infectious cause intracranial hemorragia.

**Conclusion:** H1N1 infections cause mortal viral pneumonia and VV ECMO is lifesaving.

### Extracorporeal CO2 Removal as Alternative to Tracheostomy in a Patient with Extubation Failure

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We report on a patient with chest trauma admitted to ICU after resuscitation and surgery and who fulfilled protocol-based extubation criteria 7 days after admission.

Table 1

	any thrombosis			clinically relevant thrombosis		
	Yes n = 108	No n = 65	p-value	Yes n = 48	No n = 125	p-value
days aPTT ≤50 sec (in % of total days on ECMO)	63.8	54.3	0.028	70.1	56.5	0.03
days INR ≤1.5 (in % of total days on ECMO)	92.8	93.9	0.735	96.7	91.6	0.044
renal replacement therapy (% of total patients)	38%	26%	0.111	44%	30%	0.058
cannula size, average						
outflow	22.3	22.4	0.858	22.3	22.4	0.855
inflow	18.9	19.1	0.713	18.9	19.0	0.876
duration of ECMO	12.7	12.7	0.988	13.4	12.4	0.573
D-Dimers (mg/dl, mean of all days on ECMO)	16.6	14.0	0.123	17.3	14.9	0.202
fibrinogen (mg/dl, mean of all days on ECMO)	438.5	466.8	0.279	421.9	459.5	0.128
fHb (mg/l, mean of all days on ECMO)	66.6	55.9	0.378	73.3	58.5	0.453
Antithrombin III (% , mean of all days on ECMO)	80.0	83.9	0.239	80.2	82.0	0.630
Platelets (/nl, mean of all days on ECMO)	150.0	171.3	0.162	154.5	159.3	0.758

However, despite of intermittent non-invasive ventilation the patient had to be re-intubated on day 10 due to progressive hypercapnia. We decided to support the patient with a mid-flow veno-venous ECCO<sub>2</sub>-R system to avoid tracheostomy. Sufficient CO<sub>2</sub>-removal was established with a blood flow of 1.5 l/min and the patient was successfully extubated within a few hours after initiation of ECCO<sub>2</sub>-R. Awake and spontaneously breathing the patient was weaned on ECCO<sub>2</sub>-R-day 5 and transferred to surgical ward in a stable condition.

### An Experience of V-A ECMO for Pulmonary Tumor Thrombotic Microangiopathy (PTTM) Patient

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**Introduction/Aim:** Pulmonary tumor thrombotic microangiopathy (PTTM) is a rare but lethal complication of carcinoma. It is defined as non-occlusive pulmonary tumor embolism complicated with the fibrocellular intimal proliferation of small pulmonary arteries. It eventually occludes pulmonary arteries.

**Case:** 46 years old female who has been undertaken radiation therapy for anaplastic oligoastrocytoma and taking the thymolololide presented to our hospital for cough and palpitation. 12 lead ECG showed sinus tachycardia and SIQIIIITIII, negative T in V1-3. UCG showed distended right ventricle. Enhanced chest CT showed no significant thrombus in major pulmonary artery. The patient condition deteriorated in the next morning; her blood pressure decreased to 40 mmHg, and SpO<sub>2</sub> can not be measured. The patient then become a cardiac arrest. We initiated VA ECMO. On starting the ECMO her blood pressure raised to 80 mmHg.

After starting the ECMO, her hemodynamic status was stabilized. On ICU day 3, ECMO could be weaned off. On ICU day 4, Gastroesophageal endoscopy revealed gastric cancer (Borrmann type IV). The patient suddenly arrested again in the ICU day 5, and could not be resuscitated. Autopsy revealed gastric cancer and pulmonary tumor.

**Conclusion:** We have experienced PTTM patient treated with VA ECMO. VA ECMO rapidly stabilized hemodynamic status. To the best of our knowledge, this is the first report which had shown the effectiveness of VA ECMO for PTTM patients. Recent reports indicate the effectiveness of Imatinib for PTTM patients. VA ECMO is a possible bridging therapy for deterioration of PTTM.

### 6-Min Walk Distance (6MWD) in Patients Post Respiratory ECMO.

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**Introduction/Aim:** The 6-minutes walk distance (6MWD)(1), has been shown to be a reliable test of functional capacity in survivors from acute respiratory failure (ARF) treated with conventional intensive care (2). In this study we investigated the 6MWD in patients treated with Extracorporeal Membrane Oxygenation (ECMO) for severe refractory respiratory failure.

**Methods:** A consecutive cohort of 38 adult patients, treated with respiratory ECMO, was investigated with 6MWD according to the ATS guidelines (1) median 9,5 years (6–13,5) post ECMO discharge. Predicted 6MWD for the patients was calculated (2).

**Results:** 6MWD for the group was 545,6 meters (504,8 - 586,4 IQ range), which corresponds to a 6MWD % predicted, of 83%. Median time to follow-up post discharge from ECMO was 9,5 years (6–13,8 IQ range).

Table 1

n	age (years)	male	P/F ratio	days on ECMO	6MWD	SpO <sub>2</sub> % before/after
38	52 (37–64)	24	52	17	545,6 (504,8 - 586,4)	98,3 / 98,8

Data are presented as mean (95% CI); P/F ratio calculated pre ECMO with FiO<sub>2</sub> of 1.0.

**Conclusion:** In this cohort of 38 consecutive surviving ECMO patients we found a close to normal 6MWD compared to previously published for survivors post ARF (3). If validated for the post respiratory ECMO group the 6MWD could be a reliable tool for testing the functional capacity in post respiratory ECMO follow up studies.

### Extracorporeal Carbon Dioxide Removal as A New Strategy in Difficult Weaning

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**Introduction/Aim:** Early reduction of sedation and spontaneous breathing is important for weaning from mechanical ventilation and reduces adverse effects such as infection, delirium, ICU acquired weakness. In patients suffering from emphysema, complications such as airway obstruction, high respiratory frequency and patient-ventilator asynchrony resulting in hypercapnia and respiratory acidosis interfere with the reduction of sedation. To prevent prolonged deep sedation different strategies for these patients are needed.

**Methods:** We report two cases of female patients, one intubated, the other one after tracheotomy, both suffering from emphysema, one caused by COPD and one caused by alpha1-antitrypsin deficiency. After reducing sedative medication both patients showed ineffective mechanical ventilation causing hypercapnia. Both patients received a Homburg lung as extracorporeal carbon dioxide removal (ECCO<sub>2</sub>R) reducing hypercapnia, respiratory acidosis and therefore respiratory stress.

**Results:** After establishing ECCO<sub>2</sub>R we were able to reduce the sedative medication in both cases during a short period without respiratory difficulties. The COPD patient which was intubated could be extubated but developed a delirium which led in reintubation and early tracheotomy. ECCO<sub>2</sub>R could be ended when the patients were awake, neurologically adequate and effectively ventilated in an assisted spontaneous ventilation mode.

**Conclusion:** ECCO<sub>2</sub>R can be seen as an adjunct strategy in patients developing difficult mechanical ventilation while reducing sedative medication. It may prevent prolonged deep sedation and its associated complications.

### Rescue ECMO Therapy in H1N1 Induced ARDS: A Case Report

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**Introduction/Aim:** The H1N1 strain of Influenza A is known to be highly virulent and is associated with acute respiratory distress syndrome (ARDS). Invasive mechanical ventilation (IMV) does not always provide an optimal solution. Extracorporeal membrane oxygenation (ECMO) has been shown to be a rescue treatment of severe H1N1-induced ARDS.

**Methods:** Here we describe first successful application of ECMO in H1N1.

**Results:** A 36-year-old previously healthy male was admitted to another hospital with hypoxemic respiratory failure due to H1N1. In 3days after admission he required intubation and IMV. It was not possible to achieve PaO<sub>2</sub> > 60 mmHg, SpO<sub>2</sub> > 90%. Ad-hoc venovenous ECMO with femoral and internal jugular cannulation was initiated shortly. Patient was further transferred to the ICU of our tertiary care center. Ultrarotective IMV was applied using APRV mode with Pinsp 20–22 cmH<sub>2</sub>O, PEEP 12–16 cmH<sub>2</sub>O, and FiO<sub>2</sub> 35–45%. Target tidal volume was 3–4 ml/kg PBW, and I:E ratio was 1.5:1 – 2.5:1. Patient required myoplegia for 3 days after admission. ECMO settings were as following: flow 3–4 l/min, fresh gas flow 1.5 – 2.5 (max 9.7) l/min and oxygen fraction 60–100% to achieve SpO<sub>2</sub> 92–94%. The duration of ECMO was 42 days. On day 6 patient developed nosocomial septic shock with lung abscess complicated by hemopneumothorax, hemorrhagic shock and further left lung inferior lobectomy. He required prolonged IMV following ECMO weaning, with successful return to natural airway breathing at day 67 after hospitalization.

**Conclusion:** We successfully used ECMO as a rescue therapy patient with severe H1N1 induced ARDS that allowed weaning of IMV and recovery.

### Respiratory Insufficiency: Importance of Patient Mobility and the Demand for Wearable Lung Assist Devices (LAD) - Results of a Survey

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**Introduction:** The survey evaluates the meaning of the importance of patient mobility for clinical staff in their daily business and provides information about the pros and cons resulting from a more mobile patient. In addition the value of patient mobility outside the ICU and outside the hospital was inquired. Furthermore, we asked for the demand of a wearable Lung Assist Device (LAD).

**Method:** The survey was conducted in an international convention (EuroELSO 2016) in Glasgow with the attendant expert audience (N=34).

**Results:** Most of the respondents associated patient mobility with an awake patient and mobilization out of bed. In relation to nursing effort more than half of those polled consider a more mobile patient as beneficial. There is a consensus about the positive effect of mobilization with regard to hospital stay and success of treatment. The survey revealed that COPD patients and patients waiting for lung transplantation would benefit most from a wearable LAD. Enabling the mobility for patients with respiratory insufficiency outside the ICU as well as outside the hospital is considered as very important.

**Conclusion:** The mobility of patients on the ICU suffering from respiratory insufficiency is of utmost importance for nearly 100% of the experts participating in the survey. A positive expectation of wearable LAD can be noted and most of the respondents assess the introduction of a LAD as likely.

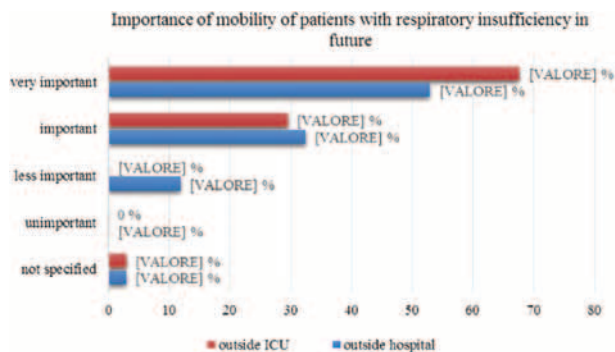


Figure 1: Importance of mobility of patients with respiratory insufficiency in future

#### Timely Treatment with Venovenous Extracorporeal Membrane Oxygenation in Acute Respiratory Failure after Cardiac Surgery with Extracorporeal Circulation

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**Introduction/Aim:** Post-cardiotomy respiratory distress syndrome is a rare but life-threatening complication. Haemodynamic impairment is common in these patients and mechanical ventilation may not provide an adequate support. In this context, venovenous extracorporeal membrane oxygenation (VV-ECMO) can be an alternative treatment. A timely institution of this support accounts for a successful treatment.

**Methods:** We have reviewed the outcome of 5 patients who developed severe acute respiratory failure after cardiac surgery on cardiopulmonary bypass and ultimately underwent percutaneous VV-ECMO.

**Results:** In four patients the VV-ECMO support was started in the first week after the cardiac operation. One patient (20%) died in the intensive care during treatment with VV-ECMO. One patient (20%) died in cardiac rehabilitation for non-respiratory or cardiac death (intestinal ischemia). Three patients (60%) were discharged from the hospital after a period of (8 +/- 3 days of VV-ECMO). One patient (20%) developed after 2 days of ECMO V-V syndrome heparin-induced thrombocytopenia, treated with conversion from heparin with fondaparinux.

**Conclusion:** Patients who develop respiratory distress syndrome Refractory to Treatment of invasive ventilation after cardiac surgery with the use of extracorporeal circulation, benefit if treated with timely treatment with percutaneous ECMO V-V within 12/24 hours after the onset of ARDS.

#### ECCO<sub>2</sub>R for Severe Hypercapnic Acidosis: Analysis of CO<sub>2</sub> Removal on Pulmonary Hemodynamics and Effects of Regional Citrate Anticoagulation.

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**Introduction/Aim:** During ECCO<sub>2</sub>R, efficiency of CO<sub>2</sub> removal and its effects on pulmonary hemodynamics are not precisely established. Moreover, this technique requires anticoagulation that may induce severe complications. The aim of this study was to determine efficiency of CO<sub>2</sub> removal, to assess its effects on right ventricular (RV) afterload and to compare regional to systemic anticoagulation.

**Methods:** This study was performed in an experimental model of severe hypercapnic acidosis performed in 2 groups of 3 anesthetized and mechanically ventilated pigs. In the first group, pigs were anticoagulated with systemic heparin while regional sodium citrate 4% solution (antagonised by calcium chloride) was used in the second group. Severe hypercapnic acidosis was obtained by reducing tidal volume (protective ventilation). Pump Assisted Lung Protection (PALP, Maquet) system was used to remove CO<sub>2</sub>.

**Results:** Mean arterial pH was normalized to  $7.37 \pm 1.4$  at an extracorporeal blood flow of 400 mL/min, coming from  $7.11 \pm 1.3$  ( $p < 0.01$ ). RV end-systolic pressure increased by over 30% during acute hypercapnic acidosis and was normalized in parallel with CO<sub>2</sub> removal. CO<sub>2</sub> extraction was not significantly increased in citrate group as compared to heparin group (Fig.1). Mean arterial pressure was significantly lower in the citrate group ( $57.0 \pm 8.3$  vs.  $68.2 \pm 10.8$  mm Hg,  $p < 0.05$ ).

**Conclusion:** ECCO<sub>2</sub>R was highly efficient to normalize pH and PaCO<sub>2</sub> and to reduce RV afterload resulting from severe hypercapnic acidosis. Regional citrate anticoagulation of ECCO<sub>2</sub>R did not improve CO<sub>2</sub> removal but induced higher rate of hypocalcemia and hypotension in comparison with heparin anticoagulation.

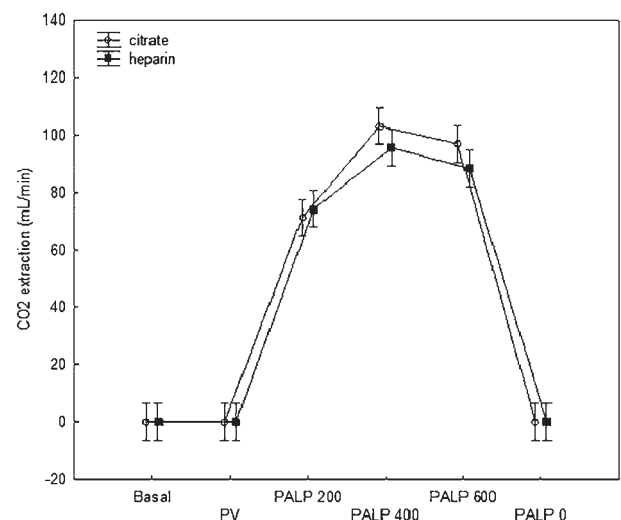


Figure 1. PV = protective ventilation, PALP 200, 400, 600, 0 = extracorporeal blood flow (mL/min)

#### Respiratory Extracorporeal Membrane Oxygenation (ECMO) in Geriatric Patients

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**Introduction/Aim:** The Aging of society is proceeding in the world. Japan is one of the most aging countries and the aging of the patients in ICU in Japan is also proceeding. ECMO for young or middle aged patients with severe respiratory failure may improve their prognosis. However, the efficacy of Respiratory ECMO for geriatric patients is unclear.

**Methods:** The single center retrospective study was performed, and respiratory failed patients treated by ECMO were enrolled, who admitted from Apr. 2013 to Aug. 2016. Geriatric ECMO group (G group) included the patients whose age was 65y or more, and Young ECMO group (Y group) included the patients whose age was 64y or less. The clinical variable and their outcome were compared between those two groups.

**Results:** 29 patients were enrolled in this study. 17 patients included in the G group, and 12 patients included in the Y group. There is no significant difference in the survival and the rate of the hospital discharge with ambulation between both two groups (G group vs Y group = 65% vs 83%,  $p = 0.49$ ; 47% vs 50%,  $p = 1.00$ ). Awake ECMO was performed in the 47% of patients in G group and 58% of patients in Y group ( $p = 0.825$ ). There was no significant difference in the length of hospital stay or ICU stay, and cost of admission.

According to the previous review of respiratory ECMO, geriatric patients were excluded from the indication of Respiratory ECMO and the feasibility of the ECMO for them is controversial. This retrospective cohort showed that the survival rate and the rate of the hospital discharge with ambulation between the G and Y group is not

difference, and there was no significant difference in the length of hospital stay or ICU stay, and cost of admission. These outcomes of Respiratory ECMO in geriatric patients are acceptable, even compared to the young patients. Although the age limit should be considered, the expansion of indication of Respiratory ECMO for geriatric patients should be also considered.

**Conclusion:** This retrospective cohort showed the outcome of Respiratory ECMO for geriatric patients was acceptable, compared to young patients.

#### A Case Report of Successful Management of Acute Respiratory Distress Syndrome in Severe Malaria by Prolonged Extra-Corporeal Membrane Oxygenation (ECMO)

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**Introduction:** Severe malaria can cause acute respiratory distress syndrome (ARDS). The treatment of ARDS is similar to other causes and acute ventilator induced lung injury should be avoided.

When hypoxia persists despite optimized ventilator settings and prone positioning, venovenous extracorporeal membrane oxygenation (vvECMO) can be an *ultimum refugium* treatment. In literature, the use of vvECMO for ARDS in severe malaria has been described only six times, of which four were successful with an vvECMO duration of shorter than 10 days. Herein, we report a case with successful management of ARDS in severe malaria by prolonged, 36 days, use of vvECMO therapy.

**Case:** A 29-year old man with malaria and ARDS and severe hypoxia was transferred to our hospital for vvECMO. The vvECMO was initiated at 4.5 L/min bloodflow. Because of high ventilation pressures and tidal volumes of 50 mL, CPAP ventilation was initiated using electrical impedance tomography (EIT). The next 21 days, the patient was not ventilated. Pleural fluid drainage and bronchoscopy followed and tidal volumes increased from 50 mL to 350 mL with EIT. After surviving multiple complications, including renal failure, bleeding and infections, vvECMO could be successfully removed on vvECMO day 36. Hospital discharge followed 11 weeks after admission.

**Conclusion:** This unique case report describes a successful prolonged, 36 day-use of vvECMO for ARDS in severe malaria, despite multiple bleeding and infectious complications, and utilizing unconventional ventilatory settings monitored by pulmonary electrical impedance tomography.

#### Factors Associated with Outcome of Patient with Acute Respiratory Failure on Pumpless Extracorporeal Interventional Lung Assist: Pilot Study

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**Introduction/Aim:** Pumpless interventional lung assist (iLA) have been advocated in patients suffering from severe acute respiratory failure who are at risk for life-threatening hypercapnia. However, there is few evidence about factors with outcome of patient with acute respiratory failure using iLA. We evaluated effect and prognostic factor of the iLA in patients with acute respiratory failure

**Methods:** We evaluated retrospectively our experience with iLA between March 2013 and August 2016. iLA was implemented patients from multiple etiologies with severe hypercapnia (pH < 7.1 and PCO<sub>2</sub> > 70 mmHg). Laboratory parameters include arterial blood gas analysis, ventilator parameters, hemodynamic parameter and adverse events were recorded serially. Our primary outcome was ICU mortality.

**Results:** Between March 2013 and August 2016, we enrolled 11 patients with severe respiratory failure,

2 patients had prone position using iLA and they all survived in ICU. iLA lead to an acute and moderate increase in arterial oxygenation (PaO<sub>2</sub>/FiO<sub>2</sub> ratio 2 hr after initiation of iLA (150 ± 25 mmHg) compared with pre iLA (110 ± 20.2 mmHg). Hypercapnia was promptly reversed within 2 hr (PaCO<sub>2</sub>, 35.9 ± 12.4 mmHg) in comparison with before (75.9 ± 23.4 mmHg, p < 0.05), which allowed a more protective ventilator strategy. In our study, ICU mortality is 36.4 %, Hospital mortality is 45.5%. SOFA score and lactate clearance were significantly related with ICU mortality.

**Conclusion:** Interventional lung assist might provide a sufficient rescue measure with easy handling properties in patients with severe hypercapnic respiratory failure. Also, prone position during iLA is safe and could be improved outcome.

#### Spontaneous Haematoma During Venovenous ECMO

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**Introduction/Aim:** The occurrence of spontaneous hematomas is a rare but worrisome complication of anticoagulants. We report three cases that occurred in our ECMO population in the last years.

Table 1

	Age	Cause of respiratory failure	Spontaneous hematoma	IAP cmH <sub>2</sub> O	Clinical course and treatment
1	43	ARDS in H1N1	retroperitoneal (lumbar)	30	Embolization x 2, new cannula for drainage, lumbotomy
2	50	ARDS in autoimmune disease	retroperitoneal (lumbar)	22	Inversion of cannulas, deconnection, embolization
3	59	Fibrotic non-specific interstitial pneumonia	rectus sheath hematoma	36	Intubation, new cannula and embolization

IAP = intra-abdominal pressure

**Methods:** During January 2009 and December 2016, 108 adult patients underwent veno-venous ECMO for respiratory support. Three patients developed spontaneous hematomas with an incidence of 2.7%.

**Results:** In the table we summarize the location of the hematomas, and the clinical course of the three patients. All the patients had a femoro-femoral approach. In all 3 cases intra-abdominal pressure (IAP) increased above 20 cmH<sub>2</sub>O, leading to impairment of ECMO blood-flow. In 2 cases a second cannula was positioned in the jugular vein for drainage, in one the femoral cannulas were inverted. All the patients were in spontaneous or assisted breathing when the complication occurred (after 17, 60 and 9 days of ECMO). In all the cases heparin infusion was stopped. APTT before heparin discontinuation ranged between 46.3 and 59.4 seconds. After urgent CT scan for identification of the bleeding vessels, all patients were transported to the angiography suite and underwent spiral embolizations (always multiple vessels were involved). All the patients were in spontaneous or assisted breathing when the complication occurred.

**Conclusion:** Though uncommon, the occurrence of spontaneous hematomas during ECMO is a challenge. Both lumbar and inferior epigastric arteries are prone to shearing stresses at branching sites. Excessive abdominal compression as those associated with cough or Valsalva manoeuvres during spontaneous or assisted breathing may favour the occurrence of spontaneous hematomas.

#### Diffuse Alveolar Hemorrhage due to Goodpasture's Syndrome Treated with Extracorporeal Membrane Oxygenation

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**Introduction/Aim:** Goodpasture syndrome (GS) is a rare autoimmune disorder characterized by circulating Anti-glomerular basement membrane (anti-GBM) antibodies mediating rapidly progressive glomerulonephritis and/or pulmonary hemorrhage.

**Case report:** We report a 19 year old male referred from an external hospital. He presented with acute onset of hemoptysis, tachypnea and hematuria. Chest x-ray showed bilateral alveolar infiltration, CT-scan revealed diffuse groundglass and basal consolidation. Laboratory testing showed elevated parameters of infection (WBC 10.8/μL, CRP93.6 mg/L) and acute kidney failure (creatinine 4.18 mg/dL urea 159 mg/dL) with urinary sediment acanthocytes. The diagnosis of Goodpasture's syndrome was made by high-titers of Anti-GBM-antibodies (>680 U/l) and a renal biopsy. We started high dose steroid therapy, chemotherapy with cyclophosphamide and plasmapheresis. Renal replacement therapy, intubation and mechanical ventilation were inevitable. Severe hypoxemia (OI 60) persisted under exhaust ventilation with high peak and plateau pressures. We established a veno-venous extracorporeal membrane oxygenation via bicaval doublelumen cannula. The following day, the patient was extubated and ambulatory on ECMO. Chest-X ray and

gas exchange improved continually. ECMO weaning was started under continuation of daily plasmapheresis. The extracorporeal support was terminated on day 12. Anti-GBM-Antibody-Titers decreased to 60 U/l at day 17.

**Conclusion:** ECMO is a lifesaving option for patients with refractory hypoxemia due to pulmonary hemorrhage. This case demonstrates the necessity of a close interaction between pneumologists, intensivists, rheumatologists and nephrologists.

#### Outcome of Adult Patients with Respiratory Failure Based on Duration of Extracorporeal Membrane Oxygenation

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**Introduction/Aim:** Prolonged use of veno-venous extracorporeal membrane oxygenation (vvECMO) is increasing for the treatment of respiratory failure in adults. We aimed to evaluate the survival based on duration of ECMO for those who received vvECMO for >1 week.

**Methods:** Among 81 patients who received vvECMO support for respiratory failure at the Severance Hospital (Seoul, South-Korea) between 2014 and 2016, 43 patients with vvECMO duration of >1 week was analyzed.

**Results:** The median age at vvECMO support was 55 years (range, 17–76). Respiratory diagnoses were pneumonia (n = 18), nonpulmonary infection (n = 5), traumatic chest/ lung contusion (n = 1), and other pulmonary causes (n = 19). Eighteen patients (42%) underwent lung transplantation with 55% in-hospital mortality. After a median follow-up of 15 months (range, 2–29), the overall survival rates at 90 days and at 1 year after ECMO was 46.1% and 34.6%, respectively. The median duration of vvECMO was 13 days (range, 8–59). Based on the duration of vvECMO, 24 patients (56%) received vvECMO for 8–14 days, 7 patients (16%) for 15–21 days, 3 patients (7%) for 22–28 days, and 9 patients (21%) for >28 days. Survival rates after treatment in each group were 83%, 71%, 67%, and 44%, respectively, while 58%, 71%, 33%, and 11% survived >90 days after decannulation, respectively.

**Conclusion:** Our data showed that the rates of those who survived >90 days and the survival rates after treatment in each group based on ECMO duration were different. Efforts are needed to improve survival outcome for patients with prolonged ECMO (>14 days).

#### Extracorporeal Membrane Oxygenation in Patients with Severe Respiratory Failure Following Burns and Smoke Inhalation Injury

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**Introduction:** Veno-venous extracorporeal membrane oxygenation (VV-ECMO) can be used as rescue therapy in patients with severe respiratory failure following burns and smoke inhalation injury. However, the reported outcomes in the literature have been varied.

**Methods:** We report our audit on clinical experience with VV-ECMO in five burn patients. Three male and two female patients (age: 28–37 years) had flame type burns and smoke inhalation injury requiring both ventilation and subsequent VV-ECMO support. Their Murray scores ranged between 3.25 and 3.75, and the Baux score between 62 and 102.

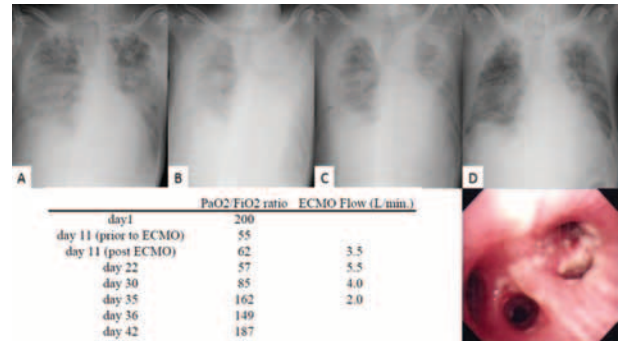
**Results:** The mean pre-ECMO conventional ventilation time was 7.4 days (3–13). The mean ECMO duration was 18 days (8–35). Three of the patients had dual lumen cannulas, the others had separate pipes. One oxygenator had to be changed due to technical failure and one patient needed 2 oxygenators. There were no other technical problems. Four patients had renal replacement therapy. All patients needed vasoconstrictor support, antibiotics and packed red blood cells (5–62 units). Three had steroid treatment. All five patients were successfully weaned from ECMO. One patient later died in multi-organ failure in the ICU, the other four patients survived.

**Conclusion:** VV-ECMO is a useful rescue intervention in patients with burns related respiratory failure. The CESAR Trial has shown improved survival in patients transported to an ECMO centre. Patients in our institution benefit from having burns and ECMO expertise under one roof. The results from this small cohort are encouraging, although more cases are needed to draw more robust conclusions.

#### A Successful Long-Term Extracorporeal Cardiopulmonary Support for Severe Pulmonary Aspergillosis: A Case Report

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**Introduction/Aim:** Extracorporeal membrane oxygenation (ECMO) is an established life-saving procedure for acute respiratory failure due to various causes. Generally, ECMO duration period range from 1 week to 2 weeks, with withdrawal recommended if no improvement is noted. We report a successful case of long-term ECMO management for respiratory failure due to invasive pulmonary Aspergillosis infection.



**Case:** A male in his 60s, without any previous underlying medical conditions, was transferred to our hospital for fever and dyspnea. On admission, the patient presented with bilateral diffuse infiltration shadow on X-ray and chest CT readings and severe hypoxemia with a PaO<sub>2</sub> / F<sub>2</sub>O<sub>2</sub> ratio of 55. The patient was intubated and underwent mechanical ventilation. Bacterial culture of bronchial-alveolar lavage performed prior to antibiotics administration was positive for *Aspergillus fumigatus*, and anti-fungal treatment was initiated. The patient's respiratory status deteriorated on the 11<sup>th</sup> admission day with no improvement to any mechanical ventilator settings, and venous-venous ECMO was introduced. The ECMO had been persisted for a long time period, with delayed improvement of respiratory status until the 39<sup>th</sup> admission day. ECMO discontinuation was possible on the 44<sup>th</sup> day, and became ventilator free on the 64<sup>th</sup> day.

**Conclusion:** Long-term ECMO might be considered if the primary causes of respiratory failure necessitating ECMO can be expected to be resolved, such as effective chemotherapy for definite pathogen. Our case indicates that ECMO can be persisted for respiratory failure due to invasive Aspergillosis until the recommended treatment duration of 4 to 8 weeks.

#### Rheumatoid Arthritis-Related Interstitial Pneumonia Successfully Treated with VV-ECMO and PMX-DHP

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**Introduction/Aim:** To date, it has been shown that acute interstitial pneumonia is poor prognosis. Recently, the usefulness of VV-ECMO (veno-venous extracorporeal membrane oxygenation) for severe respiratory failure and PMX-DHP (Polimyxin B immobilized fiber column direct hemoperfusion) for interstitial pneumonia has been reported.

**Case:** A 64-year-old man with rheumatoid arthritis-related interstitial pneumonia was admitted to our hospital with complaint of dyspnea after right upper lobectomy for the squamous cell carcinoma. Based on these clinical and laboratory findings, the patient was diagnosed with the interstitial pneumonia with acute exacerbation. Treatment was started with the steroid pulse therapy, however, he fell into severe respiratory failure and was transferred to the ICU and underwent intubation. We therefore applied VV-ECMO and PMX-DHP. We continued treatment without intubation by cyclophosphamide pulse and steroid pulse. The patient recovered from critical respiratory failure and extubated. These therapy was effective and he was discharged from the ICU.

**Conclusion:** We report a patient with rheumatoid arthritis-related interstitial pneumonia successfully treated with VV-ECMO and PMX-DHP.

#### Anticoagulation During Extracorporeal Membrane Oxygenation (ECMO) Associated with Diffuse Alveolar Hemorrhage Secondary to Wegener's Granulomatosis: Case Report of Nurses ECMO's Team in Brazil

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**Introduction/Aim:** To report a diffuse alveolar haemorrhage associated with Wegener's Granulomatosis (WG) during ECMO's support.

**Methods:** Case Report

**Results:** A 27-year-old female patient was admitted in the ICU with Acute Respiratory Distress Syndrome (ARDS) and WG. The patient quickly developed refractory hypoxemia and a veno-venous ECMO was initiated. ECMO's Team had a complication during the adjustment of anticoagulation because the presence of alveolar haemorrhage, choosing to turn off the heparin infusion. In this context, the activated Anti-Xa factor and Thromboelastography was used as differential to guide decisions on the management of haemostasis. The absence of anticoagulation did not interfere with the oxygenation capacity of the membrane. ECMO had its rotation and flow increased and, during turn based checks by the nurses, no clots were observed. Patient rested with any anticoagulation during seven days and yet no obstructive clots were found in the ECMO system, as well as no complications associated with systemic clot formation. The patient did not survive with nineteen days of hospitalization and eighteen days of membrane support and, despite specific caring, there was no improvement in alveolar haemorrhage.

**Conclusion:** ECMO management in situations of extensive bleeding, combined with interruption of anticoagulation, requires extreme attention by the whole team. The nursing care is essential in this context, since the ECMO supervising reflects on safer conditions for patient.

#### **Mechanical Ventilation in Patients with VV-ECMO: Feasibility of Ultra-Protective Ventilation in a Real-World Setting**

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**Introduction/Aim:** The use of veno-venous extracorporeal membrane oxygenation (vvECMO) in severe respiratory failure is an established rescue therapy. The optimal ventilation strategy during vvECMO remains unclear. To further reduce ventilator-induced lung injury the concept of ultra-protective ventilation has emerged. This retrospective study sought to investigate the ventilator setting used in patients undergoing vvECMO and their impact on mortality.

**Methods:** Retrospective single center analysis of mechanically ventilated patients undergoing vvECMO therapy from 01/2009 to the 06/2016. Patients on non-invasive ventilation, on veno-arterial ECMO or on low flow ECMO for carbon dioxide removal were excluded.

**Results:** 62 patients were included (age  $49.45 \pm 17.79$  a, 59.7% male). ECMO was administered using a blood flow of  $3.55 \pm 0.93$  lpm and a sweep-gas flow of  $3.37 \pm 1.51$  lpm. Upon ECMO initiation, tidal volumes could be reduced from  $5.54 \pm 2.17$  to  $3.53 \pm 1.76$  ml/kg PBW. Changes were due to reduction of the inspiratory plateau pressure ( $29.2 \pm 5.85$  vs.  $22.7 \pm 3.84$  cmH<sub>2</sub>O), thus reducing driving pressure ( $19.25 \pm 6.35$  vs.  $12.25 \pm 3.48$  cmH<sub>2</sub>O). Positive end-expiratory pressure remained constant ( $9.82 \pm 3.81$  vs.  $10.59 \pm 3.70$  cmH<sub>2</sub>O). Despite ultra-protective ventilation, gas exchange during ECMO was sufficient ( $p_aO_2$   $79.60 \pm 19.60$  mmHg,  $p_aCO_2$   $46.66 \pm 9.19$  mmHg). 33 patients (53.2%) died. There were no significant differences in ventilator parameters between survivors and non-survivors.

**Conclusion:** Our data show that ultra-protective ventilation during ECMO therapy can be feasibly applied under real-world conditions. However, a positive prognostic effect could not be detected.