Extracorporeal CO_2 removal in ICU – "Prisma Lung+" ; A DGH Experience

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CASE 1

A 57-year-old male with multiple comorbidities was being treated for a suspected community acquired pneumonia in the ward on oxygen therapy. He went on to develop Type 1 RF necessitating critical care admission for advanced respiratory management. On admission into ICU, he was immediately intubated.

CT Chest prior to ITU admission revealed a right lower lobe consolidation with effusion with subpleural bullae. Blood cultures were positive for Streptococcus pneumonia for which antibiotics were commenced. The patient was COVID-negative.

The patient went on to develop Type II RF on Day 2, with chest x-ray worsening consolidation. The patient was put in a prone position to improve ventilation. Sustained hypercarbia was noticed and was not amenable with conventional ventilatory modes. The patient was supined and was started on Prisma Lung for CO2 clearance and for lung protective measures with acceptable parameters. There was an initial drop in PCO2, followed by a demonstration of poor compliance with ventilation. A repeat CT chest on Day 3 revealed a new ground glass appearance on the right lower side with fibro proliferative changes. Thrombotic events were not observed in the patient when on PL. The patient was referred to regional ECMO centre but did not meet the criteria for acceptance. The patient's respiratory and metabolic parameters continued to improve on Prisma Lung over the next 3 days. The patient was extubated on Day 6 and was stepped down from Intensive care.

CASE 2

A 67-year-old fit and healthy woman was being treated for a community acquired pneumonia in the respiratory ward during which she started requiring increased oxygen requirements to maintain PO2 >8. Patient went on to develop Type 1RF for which she was transferred to critical care for advanced respiratory support. Patient was immediately intubated on admission.

CTPA was performed prior to ICU admission showed no evidence of PE but demonstrated ground glass changes in both the lungs and reactive lymph node changes in the anterior tracheal region. The patient tested negative for COVID, atypical respiratory bacteriae with marginally positive pANCA. The patient was receiving the appropriate antifungal and broad-spectrum antibiotics. No growth were seen on repeated blood cultures since admission.

The patient did not meet the metabolic parameters for ECMO support on ITU admission. The ECMO team advised to start Epoprostenol nebulizers in the meantime. Due to deteriorating Type 2 RF and metabolic acidosis, the patient remained proned for 12 hours before commencing Prisma lung+ and haemodialysis on Day 3. Over the course of 4 days, the patient was proned and supined twice (for high FiO2 requirements). Patient was additionally pulsed with steroids for 3 days on rheumatological advice. The patient's pCO2 levels were within the acceptable levels over the next 3 days without any significant deterioration. Thrombotic events were not observed in the patient when on PL. On further evaluation from the ECMO team, the patient was accepted for ECMO and for further management.

PARAMETERS

	Baseline	1 hr	4 hr	8 hr	16hr	24hr	48hr	72hr	96hr	POST (after 24Hrs)
Driving Pressure	28	32	25	26	32	27	24	24	20	18
FiO2	55	55	55	50	50	50	50	45	35	35
Noradrenaline	0.06	0.06	0.05	0.02	0.01	0	0	0	0	0
PaCO2	NA	7.47	6.86	7.7	7.40	7.38	7.41	7.45	8.27	8.05
Anticoag Units/hr	NA	1100	1100	1150	1200	NA	1260	1540	1260	
CRP	182		141			117			87	69

PARAMETERS

	Baseline	1 hr	4 hr	8 hr	16 hr	24 hr	48 hr	72 hr	96 hr	120 hr	POST
Driving Pressure	20	22	21	19	19	19	20	22	18	22	22
FiO2	100	70	60	60	60	60	55	50	60	55	55
PaCO2	7	6.56	6.45	6.01	7.57	7.6	7.7	9.4	8	6.55	7.72
PH	7.312	7.321	7.343	7.372	7.319	7.32	7.29	7.2	7.26	7.351	7.32
ETCo2 kpa	5.8	5.2	4.9	4.9	5.5	5.3	5.5	5.9	5.5	4.1	4.7
Anticoag ml/hr	NA	1.6	1.6	1.6	1.9	2.1	3.7	2.2	2.9	2.5	2.9
CRP	149					96		32		96	

DISCUSSION

Extracorporeal carbon dioxide removal (ECCO2R) therapy was first introduced in 1980 as a treatment for refractory acute respiratory failure (ARDS) to prevent ventilator-induced lung injury. While the principles of gas exchange are similar to that of extracorporeal membrane oxygenation (ECMO), ECCO2R is primarily utilised in hypercapnic respiratory failure, where it may be provided at lower flow rates (0.3l/min - 1l/min) using smaller extracorporeal membranes than ECMO.

The Prisma Lung+ (PL+) membrane is a revised version of the original Prisma Lung (PL) membrane that operates on the Baxter's PrisMax (RRT) platform. PL+ differentiates itself from other ECCO2R devices by being easier to set up and manage. It utilises a vascular access identical to CRRT. The notable feature of PL+ is its ease of use, which does not necessitate much professional training. PL+ also eliminates the need for staff, including perfusionists, in its setup, allowing it to be used at district general hospitals that do not have ECMO facilities. PL+ acts as a promising strategy for managing worsening hypercapnia while also assisting in lung-protective ventilation.

CONCLUSION

We have now used Prisma Lung + in 7 patients observing a positive outcome in 3 of them. Prisma Lung+ acts as a bridging tool to ECMO in district hospitals where ECMO facilities are not available. Further studies and trials are required to formulate protocols in its utility in intensive care.

REFERENCES

1) Hospach, I., Goldstein, J., Harenski, K. *et al.* In vitro characterization of PrismaLung+: a novel ECCO$_2$R device. *ICMx* **8**, 14 (2020). https://doi.org/10.1186/s40635-020-00301-7