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Severe respiratory failure and traumatic brain injuries: What do we know?

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Extracorporeal membrane oxygenation (ECMO) is a form of mechanical circulatory support that can be lifesaving in people with potentially reversible heart or lung injuries. ECMO is nearly always used urgently, when all other treatment options for cardiopulmonary injury have failed and high mortality is otherwise expected. Standard ECMO treatment involves venous drainage from the femoral vein or left atrium with artificial extra-circulatory oxygen exchange. Return to the body is through the same veins (veno-venous) or arterial system via the femoral artery or ascending aorta (veno-arterial). Compared with cardiopulmonary bypass circuit, ECMO is transportable, smaller, closed to the atmosphere, and can treat a patient for several days to weeks.

Neurological consequences of severe respiratory failure and its different management strategies in adults are likely common but uncharacterized and poorly described in the reviewed literature.

Development of severe respiratory failure (SRF) occurs in 20–25% of patients with isolated severe traumatic brain injury (TBI) and is associated with a threefold increase in mortality, or patients remaining in a vegetative state.[1] It has been attributed mostly to aspiration, infection, neurogenic pulmonary edema, and release of pro-inflammatory mediators into the systemic circulation causing ultrastructural damage in type II pneumocyte.[2] This decreases the pulmonary tolerance of subsequent mechanical stress due to mechanical ventilation. Actually, some data suggest that the main feature of ALI/ARDS in brain-injured patients is the presence of a poor oxygenation (reduced PaO_2/FiO_2 ratio) accompanied by a moderate increase in the elastance of the respiratory system even though these patients had a normal chest X-ray.

Ventilatory support for such patients could be difficult with a lot of challenges to keep optimal oxygenation and acceptable level of blood carbon dioxide.
It involves the application of positive end-expiratory pressure (PEEP) to recruit collapsed alveoli, improve arterial oxygenation, and reduce elastance of the respiratory system. Although improving oxygenation is a key factor for optimizing O_2 delivery to the brain, clinical studies provide contradictory information on the use of PEEP in patients with acute lung injury (ALI) complicating severe brain injury.
Furthermore, we tend to use higher tidal volumes in patients with acute brain injury because mild hypocapnia is a key factor in the clinical management of raised intracranial pressure, which is a frequent abnormality in such patients;[3,4] this would be an injurious ventilator strategy and may present a further relevant inflammatory stimulus. Moreover, it has been shown that the use of high tidal volumes for the first 48 h after ICU admission is associated with the development of ventilator-induced lung injury.[4]
In addition, one of the recognized methods in improving oxygenation in SRF patients is the use of prone position, because it improves the lung mechanics and augments oxygenation. Studies have demonstrated that patients with unstable intracranial pressure (ICP) have higher ICP in the horizontal position sideways. Therefore, the recommended position for this patient cohort is a 30-degree head-up tilt combined with a straight head position.[4]
Furthermore, TBI patients who require ECMO support for their SRF will need full anticoagulation, as the circuit poses considerable derangement in the hemostatic system with increased platelet consumption and a higher risk of intracranial bleeding. There have been several reports of ECMO without anticoagulation therapy, but so far with no evidence or good literature to support this notion.[5]
Although some controversy and difficulties exist, it seems that multiorgan clinical approach instead of single-organ approach represents the optimal way in clinical management of patients with ALI/SRF and TBI.

Keywords: TBI, SRF, ECMO, ICP, PEEP, severe respiratory failure, positive end-expiratory pressure, intracranial pressure, traumatic brain injury

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