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Negative pressure ventilation protects the brain

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Dear Editor,

With great interest we have read the recent paper in the journal 'Critical Care', titled: 'The future of intensive care: delirium should no longer be an issue', by Kotfis et al. [1]. Kotfis et al. state that the major factor to prevent delirium on an intensive care unit (ICU) is an awake, non-sedated patient [1]. However, the standard mechanical ventilation support on the ICU is through positive pressure ventilation (PPV), and in the cases that this ventilation support requires intubation of the patient, sedatives are frequently administered. Sedation is a major risk factor to develop delirium [2, 3]. Delirium is harmful for the brain as it is associated with long-term cognitive impairment [3].

Kotfis et al. recommend that new technologies should be implemented for delirium prevention [1]. In response to that suggestion, we would like to draw the attention of the ICU community to the reintroduction of negative pressure respiratory support [4, 5]. Patients receiving ventilation support by negative pressure ventilation (NPV) do not require intubation, so the need for sedation is greatly reduced. Therefore, NPV will avoid one of the major risk factors for delirium: sedatives. Moreover, since patients remain conscious during negative pressure ventilation support, the medical staff and family can continue to communicate with the patients. This diminishes the risk of developing a post-intensive care syndrome

(PICS), which includes not only cognitive decline but also psychiatric symptoms like depression and post-traumatic stress disorder (PTSD) [1, 2].

By avoiding the use of sedatives negative pressure respiratory support protects the brain. NPV may prove to be a worthy addition to the current range of respiratory support strategies [4, 5].

Author's reply to Correspondence "Negative pressure ventilation protects the brain"

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This comment refers to the article available online at <https://doi.org/10.1186/s13054-022-04077-y>.

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We would like to thank van Rijn and colleagues for taking time to read our Viewpoint recently published in *Critical Care* [1] and raising attention of the possible benefits of continuous external negative-pressure ventilation (CENPV) in the context of delirium. We agree that excessive sedation is one of the major factors contributing to the development of delirium in the intensive care unit (ICU) as is intubation and continuous positive-pressure ventilation (CPPV). The COVID-19 pandemic, with the initial ventilator shortage, has been an overwhelming global challenge, but it also brought our attention to technology advances in the field of mechanical ventilation and towards the use of modalities that do not require tracheal intubation.

Experimental data have shown that continuous external negative-pressure ventilation simulates natural lung movements, reduces the incidence of barotrauma and adverse cardiovascular events [6]. Negative-pressure ventilation provides more physiological inflation of the lung volume during both inspiration and expiration and may result in better oxygenation and less lung injury as compared with CPPV [6]. According to Raymondos and colleagues in patients with acute respiratory distress syndrome (ARDS) CENPV with tank respirator leads to improved gas exchange at lower transpulmonary, airway and intraabdominal pressures [7].

However, the effects of CENPV on the brain and its association with delirium remain unknown. Palmer et al. reported a decrease in cerebral blood volume and a decrease in both oxygenated and deoxygenated hemoglobin during CENPV in newborns, suggesting increased venous drainage from the cerebral circulation during negative pressure ventilation [8].

Nevertheless, to decrease the incidence of delirium many overlapping factors must be considered. The development of delirium in critically ill patients is multifactorial and does not entirely rely on sedation practices, but rather on the way we manage critically ill patients in general [9]. With CENPV a range of possible factors contributing to delirium exist that include limited access to patients for nursing procedures, possible sensory deprivation and muscle wasting through prolonged immobilization, limited physiotherapy, and poor sleep hygiene. Moreover, the nursing workload is likely to be increased. Despite unquestionable advantages, CENPV due to its robust size and technical requirements that causes limited mobility may be another factor predisposing the patients to delirium. Therefore, further studies are necessary in this field. The mainstay of delirium management is humanitarian care through good sedation practices, excellent pain relief, respiratory support personalized to suit patients' individual needs, and optimal

non-pharmacological support in healing environment that minimizes stressors [1, 9].

Abbreviations

ICU: Intensive care unit; NPV: Negative pressure ventilation; PICS: Post-intensive care syndrome; PPV: Positive pressure ventilation; PTSD: Post-traumatic stress disorder.

Acknowledgements

We thank JP Zwart for writing assistance.

Author contributions

CvR, JvE and DH wrote the manuscript. MC, PP, JR and DMcK contributed to the discussions during the conception of this work. All authors added to the drafts and approved the final version.

Funding

None.

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

Prof David Howard is the voluntary, non-paid Chairman of the UK Exovent Charity. David McKeown, civil engineer, is a trustee of the UK Exovent Charity. Exovent Charity is a UK registered charity no. 1189967: 10 Queen St Pl, London EC4R 1BE, UK. All other authors declare that they have no competing interests.

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Received: 10 August 2022 Accepted: 25 August 2022

Published online: 31 October 2022

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