Researchers investigate personalised mechanical ventilation of COVID-19 patients using computer simulations

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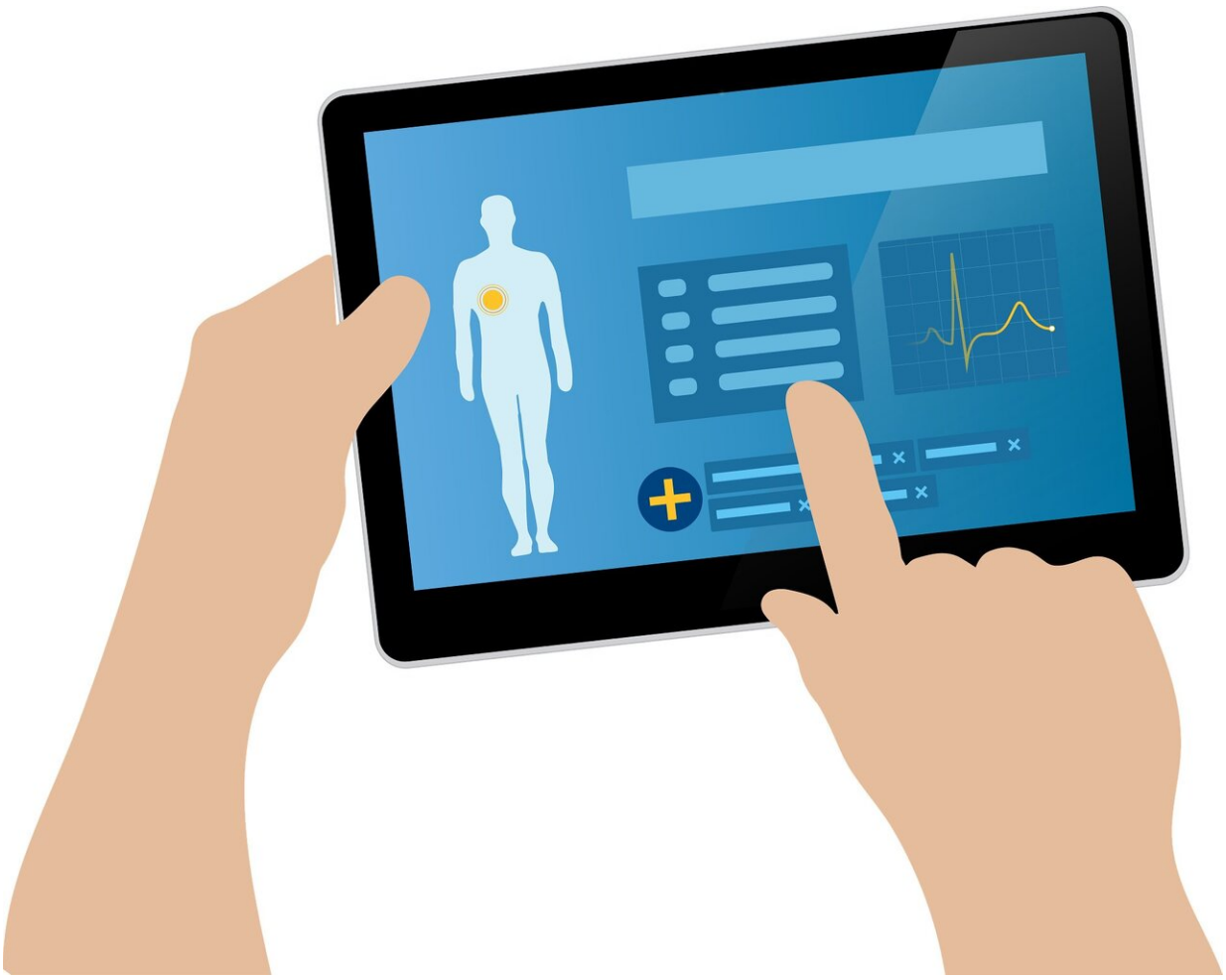

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Initial clinical guidelines for mechanical ventilation of COVID-19 patients suggested following standard approaches used in the treatment of acute respiratory distress syndrome (ARDS), which is characterised by rapid onset of widespread inflammation in the lungs.

However, emerging clinical experience in China, Italy, the UK and elsewhere suggests that some patients with COVID-19 pneumonia present with a particular a form of the syndrome, characterised by severe hypoxemia (inadequate oxygen in the blood) with relatively well-preserved lung mechanics. The pathophysiological basis for this particular characteristic of COVID-19 ARDS remains unclear, and is currently the subject of intense debate among clinicians, since it may have implications for ventilator management.

Engineers from the University of Warwick are leading a project, which has received funding of £342,863 from EPSRC under the UK government's programme for research on COVID-19, to work with clinicians from the University of Nottingham over the next 18 months to investigate optimal strategies for mechanical ventilation of COVID-19 patients.

The first results from the project have now been published in the paper, titled "In-silico modeling of COVID-19 ARDS: pathophysiological insights and potential management implications," in the journal *Critical Care* Explorations, an official journal of the Society of Critical Care Medicine, which aims to rapidly communicate new ideas and innovations of relevance to clinical practice.

Researchers adapted a state-of-the-art computational simulator, which has been developed to investigate mechanical ventilation in conventional ARDS, to provide new evidence that the particular characteristics of COVID-19 ARDS may be the result of the virus disrupting blood flow through the lung – blocking blood flow to functioning areas by

constricting blood vessels and/or causing tiny clots called microthrombi, and diverting blood flow to damaged areas of the lung. Evaluation of some mechanical ventilation strategies using this model showed that they could be ineffective or even injurious to the lungs of certain COVID-19 patients.

Professor Declan Bates, the Principal Investigator from the School of Engineering at the University of Warwick comments:

"Some ventilation strategies could be ineffective or even cause damage to patients if they don't adequately reflect their individual pathophysiology – given the heterogeneity of COVID-19 ARDS patients, a personalised approach to treatment is vital."

"Our interdisciplinary group of engineers and clinicians is leading worldwide efforts to exploit the power of computational modelling to rapidly advance our understanding of COVID-19 pathophysiology, and develop personalised ventilation strategies for this challenging disease."

Professor Jonathan Hardman, the Principal Investigator from the School of Medicine at the University of Nottingham adds:

"Traditional approaches to investigating the complex pathology of poorly understood diseases (such as COVID-19 critical illness) tend to yield inconclusive results due to the difficulty of clinical data collection and the inherent noise in the data.

"Our approach, using high-fidelity, deeply-validated modelling allows rapid exploration of the mechanisms of disease states, and pre-clinical testing of potential therapeutic approaches, accelerating the development of effective treatments for the devastating critical illness that can develop in COVID-19."

More information: Anup Das et al. In Silico Modeling of Coronavirus Disease 2019 Acute Respiratory Distress Syndrome: Pathophysiologic Insights and Potential Management Implications, *Critical Care Explorations* (2020). DOI: 10.1097/CCE.0000000000000202