Intensive Care Med (2024) 50:1961–1963
https://doi.org/10.1007/s00134-024-07599-x

CORRESPONDENCE

Setting ventilation: what if tomorrow's technology solutions were possible today?

James Geoffrey Chase[1*], Thomas Desaive[2], Cong Zhou[1], Qianhui Sun[2] and Bernard Lambermont[3]

We read with interest the article by Gattinoni et al. [1], and the subsequent spirited discussion [2, 3]. We are responding to the article conclusion pointing out the multi-factorial demands in setting ventilation:

> *In conclusion, while recruitability gives important information on the severity of disease and the amount of atelectatic lung, PEEP selection requires an integrated assessment of other variables such as elastance and transpulmonary pressures and hemodynamics to be truly personalized. Attempts to PEEP selection only to recruitability may lead to confusion and potentially injurious ventilatory settings.*

We also respond to the authors' later response noting the potential of new technologies and solutions [3]:

> *Some of these options may include automated multi-parametric monitoring and modelling, which can predict response to treatment, such as the use of computational models ("digital twins") to estimate non-measurable parameters in clinical trials and provide a physiological interpretation of their findings.*

However, the overall tone of the discussion seems to indicate a lack of possibility and the difficulty in addressing key clinical metrics they have noted all at once, with an idea that these answers were, at best, tomorrow's technology. We would simply ask:

What if every breath, or at any clinically reasonable interval, you could accurately predict patient-specific responses to changes in ventilation inputs, including:

- Recruitability, volume lost or gained as you change positive end-expiratory pressure (PEEP) [4].
- Peak volumes and pressures for any change in PEEP or mode [4].
- Distension and its amount in cmH_2O for any change in pressure or volume delivery [5].

What if you were also monitoring the magnitude, frequency, and type of asynchrony [6], thus accounting for patient–ventilator interactions?

Tracked over time, these patient-specific metrics differentiate responders and non-responders in all cases and can track how responsiveness changes. All these metrics together would be necessary to make a reasonably comprehensive effort to optimise and personalise ventilation.

What if these metrics were physics based and explainable, rather than black-box? And what if they were highly accurate in prediction?

What if these metrics were then wrapped into local clinical guidelines, protocols, and care approaches to create a "one method fits all" approach in contrast to today's frequent "one size fits all (plus tailoring)" protocolised care? What if Fig. 1 was possible, every breath or whenever you wanted?

What if tomorrow's ventilation solutions were possible today?

*Correspondence: geoff.chase@canterbury.ac.nz
[1] Department of Mechanical Engineering, Centre for Bioengineering, University of Canterbury, Christchurch, New Zealand
Full author information is available at the end of the article

This comment refers to the article available online at https://doi.org/10.1007/s00134-024-07351-5.

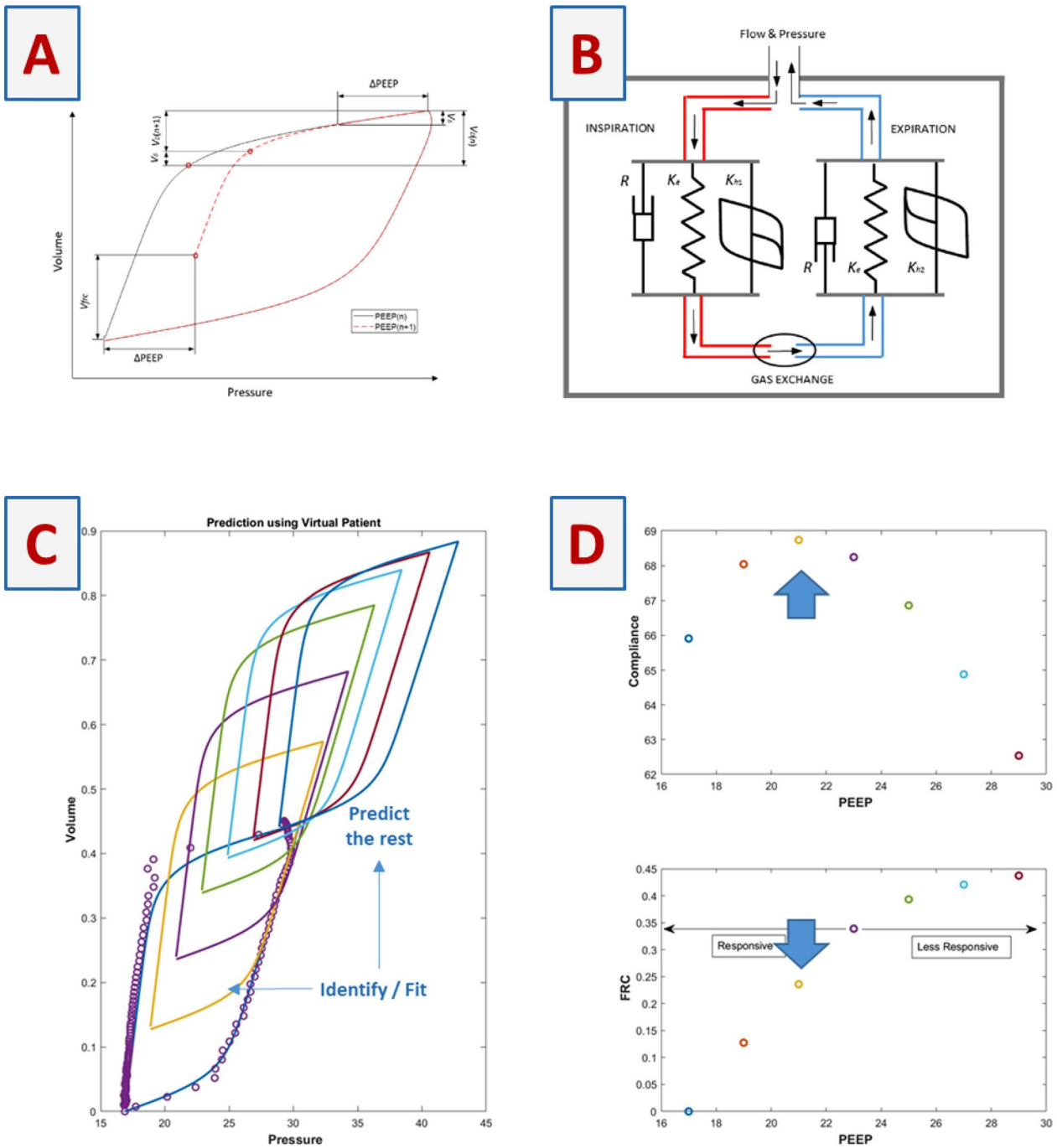

Fig. 1 **A** Measure airway pressure and volume; **B** identify a nonlinear Digital Twin model; to **C** predict what changes in PEEP (in this case) would do to peak pressures, volumes, and distension; so you could **D** use them in a protocol to ventilate at, just for example maximum compliance over PEEP, or slightly lower and maximum recruited volume before recruitability declines

Author details
[1] Department of Mechanical Engineering, Centre for Bioengineering, University of Canterbury, Christchurch, New Zealand. [2] GIGA In-Silico Medicine, University of Liege, Liege, Belgium. [3] Department of Intensive Care, Centre Hospitalier Universitaire de Liege, Liege, Belgium.

Declarations

Conflicts of interest
The authors declare that they have no conflict of interest.

Publisher's Note

Accepted: 1 August 2024
Published: 19 August 2024

References

1. Gattinoni L, Collino F, Camporota L (2024) Assessing lung recruitability: does it help with PEEP settings? Intensive Care Med 50(5):749–751
2. Briassoulis G, Briassoulis P, Miliaraki M, Ilia S (2024) Entangled in stagnant recruitment delusions. Intensive Care Med. https://doi.org/10.1007/s00134-024-07445-0
3. Collino F, Gattinoni L, Camporota L (2024) Are we ready to harness AI and digital modelling for precision in PEEP settings? Intensive Care Med 50(7):1177–1178
4. Caljé-van der Klei T, Sun Q, Chase JG, Zhou C, Tawhai MH, Knopp JL, Möller K, Heines SJ, Bergmans DC, Shaw GM (2024) Pulmonary response prediction through personalized basis functions in a virtual patient model. Comput Methods Programs Biomed 244:107988
5. Sun Q, Chase JG, Zhou C, Tawhai MH, Knopp JL, Möller K, Shaw GM (2022) Over-distension prediction via hysteresis loop analysis and patient-specific basis functions in a virtual patient model. Comput Biol Med 141:105022
6. Zhou C, Chase JG, Sun Q, Knopp J, Tawhai MH, Desaive T, Möller K, Shaw GM, Chiew YS, Benyo B (2022) Reconstructing asynchrony for mechanical ventilation using a hysteresis loop virtual patient model. Biomed Eng Online 21(1):16