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# Predicting mechanically ventilated patients future respiratory system elastance – A stochastic modelling approach

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## Abstract

Background and objective: Respiratory mechanics of mechanically ventilated patients evolve significantly with time, disease state and mechanical ventilation (MV) treatment. Existing deterministic data prediction methods fail to comprehensively describe the multiple sources of heterogeneity of biological systems. This research presents two respiratory mechanics stochastic models with increased prediction accuracy and range, offering improved clinical utility in MV treatment. Methods: Two stochastic models (SM2 and SM3) were developed using retrospective

patient respiratory elastance ($E_{rs}$) from two clinical cohorts which were averaged over time intervals of 10 and 30 min respectively. A stochastic model from a previous study (SM1) was used to benchmark performance. The stochastic models were clinically validated on an independent retrospective clinical cohort of 14 patients . Differences in predictive ability were evaluated using the difference in percentile lines and cumulative distribution density (CDD) curves. Results: Clinical validation shows all three models captured more than 98% (median) of future $E_{rs}$ data within the 5th – 95th percentile range. Comparisons of stochastic model percentile lines reported a maximum mean absolute percentage difference of 5.2%. The absolute differences of CDD curves were less than 0.25 in the ranges of $5 < E_{rs}$ ($cmH_2O/L$) < 85, suggesting similar predictive capabilities within this clinically relevant $E_{rs}$ range. Conclusion: The new stochastic models significantly improve prediction, clinical utility, and thus feasibility for synchronisation with clinical interventions. Paired with other MV protocols, the stochastic models developed can potentially form part of decision support systems, providing guided, personalised, and safe MV treatment. © 2022 Elsevier Ltd

Author keywords

Mechanical ventilation; Patient-specific; Respiratory elastance ; Respiratory mechanics; Stochastic model

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