Stochastic virtual patient-guided mechanical ventilation treatment: A virtual patient study with mechanical power consideration

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Abstract

Background and Objective: : Computerised decision support systems (CDSS) in mechanical ventilation (MV) provide individualised, closed-loop treatment but often require extensive input parameters, which are challenging to obtain continuously in clinical settings. Many also fail to incorporate mechanical power (MP) and MP ratio — recently identified as significant predictors of patient outcomes. This study introduces the Stochastic Virtual Patient Ventilation Protocol (SVP VENT), a model-based CDSS addressing these limitations. Methods: : The SVP VENT Protocol integrates a stochastic virtual patient model to predict temporal lung elastance, E_{rs}, trends and deliver closed-loop, lung protective ventilation minimising MP ratio and driving pressure. The protocol was validated against the VENT and SiVENT protocols using an established virtual patient platform comprising over 1229 h of both volume control (VC) and pressure control (PC) retrospective

MV data. Patient responses were monitored to ensure adherence to accepted clinical safety guidelines. Results: : The SVP VENT protocol consistently outperformed retrospective clinical data, VENT and SiVENT protocols in ensuring adherence to clinical safety metrics, achieving an all-adherence rate of ~57% and ~67% for the VC and PC cohorts, respectively. Across cohorts, the protocol maintained MP and MP ratio levels below safety thresholds (12 J/min and 4.5, respectively), and extended intervention intervals up to 3 h, potentially reducing clinical workload. Conclusion: : Overall, the virtual trial demonstrates the SVP VENT protocol's potential to enhance MV management by extending intervention intervals, while maintaining patient safety. These findings support initial clinical trials to evaluate the protocol's impact on clinical workload and patient safety over prolonged monitoring periods, facilitating its integration into standard clinical practices. © 2025 The Author(s)

Author keywords

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Abstract

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