Use of the INVENT system for standardized quantification of clinical preferences towards mechanical ventilator settings

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Introduction: Selecting appropriate mechanical ventilator settings is a difficult task requiring a compromise between conflicting clinical goals of securing gas exchange and avoiding ventilator induced lung injury. Guidelines have been successfully evaluated for acute lung injury and acute respiratory distress syndrome [1]. Observational studies have shown these guidelines are slow to be fully accepted and employed in clinical practice [e.g. 2], but these studies are unable to compare different clinicians' preferences under identical circumstances. The purpose of this work was to build a computer system for standardized quantification of clinical preferences towards mechanical ventilator settings. The system is based on the INVENT decision support system [3], which includes physiological models enabling simulation of patients' response to changes in ventilator settings. The system was used to quantify clinicians' preferences for inspired oxygen fraction (FiO_2), tidal volume (Vt) and respiratory frequency (f), which were then compared to suggestions by INVENT.

Methods: Figure 1 illustrates the use of physiological models for simulating mechanically ventilated patients. Three models are used describing pulmonary gas exchange, acid-base chemistry of blood and lung mechanics. Clinicians can get an overview of the patient state described by model parameters and measured values. The system simulates changes in patient state for variations in FiO_2, Vt and f. Clinicians can vary the three settings until the preferred combination of settings and simulated outcome are found. Preferred settings are automatically registered for later analysis. The system requires clinicians to assume model simulations are correct, accept levels of PEEP and I:E ratio as appropriate and assume patients weigh 70 kg.

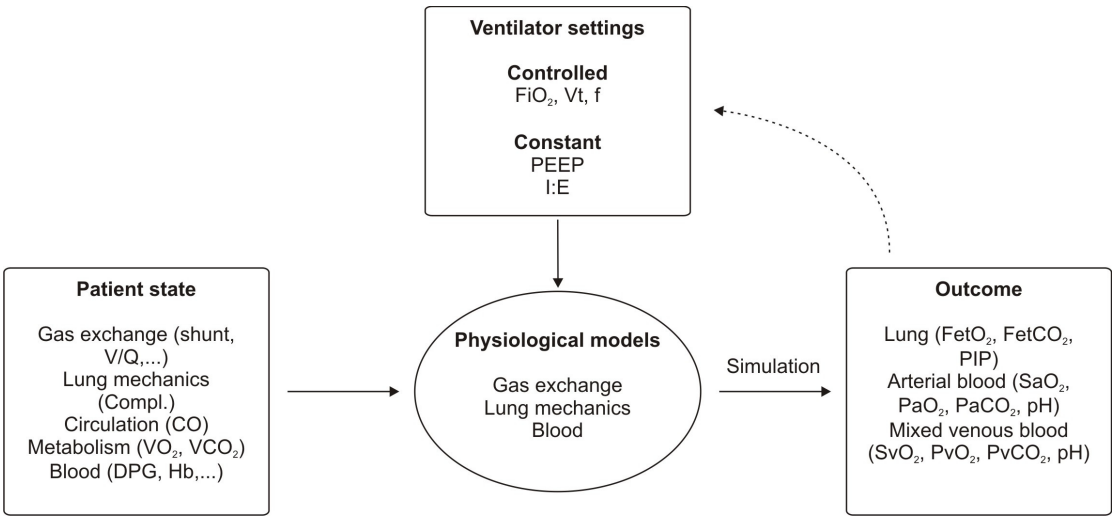

Figure 1: The use of physiological models for simulating mechanically ventilated patients. Finding the most appropriate settings is an iterative process as illustrated by the dashed arrow.

Results: The system was successfully used in a study quantifying preferences of 10 senior intensive care clinicians from the 4 university hospitals in Denmark. The clinicians individually selected their preferred settings in 10 real patient cases described by the models and presented to the clinicians in a random order. Afterwards each clinician was presented with the 9 other clinicians' and INVENT's selected ventilator settings and resulting outcomes, and were requested to rank the selections. The registered ventilator settings selected by clinicians and INVENT varied substantially and the subsequent ranking (1-11) by clinicians for each patient case showed a large variability in what was considered best practice. INVENT had the 3rd best average rank with rankings ranging from 3 to 10.

Discussion: The results indicate a lack of consensus on what is considered the best levels of FiO_2, Vt and f. The study omits selection of PEEP and I:E ratio, but including these settings would unlikely lead to greater consensus. The study furthermore demonstrates the possible use of physiological models for standardized evaluation of clinical preferences and as a tool to reach consensus. The mathematical functions describing clinical preferences in a decision support system as INVENT could then be tuned to fit this new consensus.

References:

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