

BACK TO THE BASICS OF INTENSIVE CARE: THE IMPACT OF MODEL BASED THERAPEUTICS ON VENTILATION AND SEDATION MANAGEMENT

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Objective: (i) To review the pathophysiology of lung in critically ill patients and present a model-based method of quantifying levels of recruitment and responses to changes in mechanical ventilation.
(ii) To examine the importance of integrating respiratory management of critical illness with improved methods of managing sedation and agitation and the impact of this combined approach on patient outcome.

Background and Review:

Modelling the fundamental dynamics of physiological systems, particularly for different therapeutics (e.g. ventilation) can enable more optimal therapies and implementation, as well as the potential for automating their application or creating decision support systems based on objective data. In essence, good fundamental models expand the simple data measured into a larger, more powerful clinical context so that they can be more objectively applied to improve care. A novel model of lung mechanics that estimates threshold opening pressure (TOP) and threshold closing pressure (TCP) of alveolar units captures the fundamental characteristics of acute lung injury and ARDS. Changes in the distributions of TOPs and TCPs can be used to inform the clinician about the level of de-recruitment and the impact of changes in therapy.

While good clinicians may require little assistance, management of ventilation and weaning is only as good, like a rugby team, as the worst player in the unit. Similarly, understanding the patient condition and dynamics is a direct lead-in to diagnosis, particularly if used to diagnose levels of function, such as the percentage of ARDS affected lung.

Patient agitation is a universal phenomenon in the critically ill. The result of suboptimal management is either dangerous agitation or over-sedation. This impacts significantly on intensive resources with increased length of stay, resource utilisation, and morbidity such as ventilator associated pneumonia. Current practice is very much an 'art form' that relies heavily on the intuition and experience of nursing staff. It is hypothesized that by combining greater resolution of agitation metrics using signal processing of physiological data, pharmacodynamic models of patient responses to therapies and better drug delivery algorithms could vastly improve on current standards of practice.

Finally, new clinical research using a multimodal approach to weaning through improved ventilation *and* sedation is showing promising results, though not without significant challenges.

Summary: Sub-optimal ventilation therapies and over-sedation have significant adverse impact on intensive care resources. Interventions to optimise both methods of management may result in significant reductions in resource utilisation, morbidity and mortality.