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Title: Optimisation of tidal volume (Vt) for minimising tidal lung overdistension during mechanical ventilation in ALI/ARDS: A modelling approach

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Body: BACKGROUND: Respiratory system reactance (Xrs) measured by the forced oscillation technique (FOT) allows the identification of the open lung PEEP (PEEPol) during mechanical ventilation (Dellacà Intensive Care Med, 37(6):1021-30, 2011) and could potentially provide useful information for optimising also Vt. In this study we developed a mathematical model that uses Xrs measured within-breath during a decremental PEEP trial. The model identifies the highest Vt that prevents tidal overdistension on an individual basis. METHODS: We adapted the mathematical model proposed by Hickling (Hickling, Am J Respir Crit Care Med, 163: 69–78, 2001) to make use of Xrs data measured at end-inspiration and at end-expiration during a PEEP trial and we applied the model to data recorded in a porcine surfactant depleted model of ALI/ARDS. For each subject the highest Vt preventing tidal overdistension was identified as the point of maximal curvature (VtPMC) of the tidal p-v loop. RESULTS: PEEPol as defined by the simulated data was on average±SD 10±2 cmH2O irrespective of Vt. The same Vt could result in intra-tidal recruitment below PEEPol or overdistension depending on the PEEP level. The VtPMC was an average ±SD of 13±3 ml/kg at PEEPol and decreased with increasing PEEP (VtPMC=11±2 ml/kg at PEEPol+2 cmH2O). CONCLUSION: Our simulations showed that to provide a lung protective ventilation there is a maximum Vt which changes significantly with the level of PEEP applied. Once the PEEPol has been identified by FOT, our mathematical model fitted on Xrs data could help in identifying the maximal Vt that prevents tidal overdistension for each individual patient.