ABSOLUTE EIT COUPLED TO A BLOOD GAS PHYSIOLOGICAL MODEL FOR THE ASSESSMENT OF LUNG VENTILATION IN CRITICAL CARE PATIENTS

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Introduction

The authors propose to use a previously developed data-driven physiological model (SOPAVent [1]) for continuous and non-invasive blood gas predictions in combination with the Sheffield Mk3.5 Absolute Electrical Impedance Tomography (aEIT) [2] system to assess lung functions and guide ventilation therapy in critical care patients (Fig. 1).

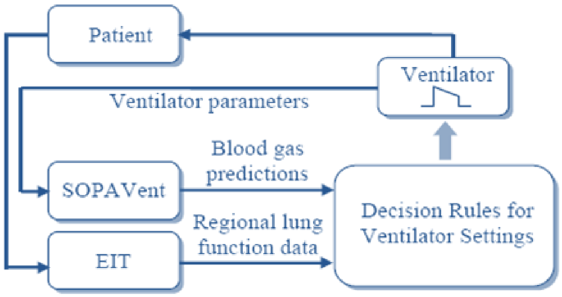

Fig. 1 Advisory system for the management of ventilated critical care patients.

PEEP (mmHg)	MEEV (litres)	PaO2 (mmHg)	PaCO2 (mmHg)

Methods

In aEIT, the Mean End Expiratory lung Volume (MEEV) should have the ability to provide regional information on the patient's lung behaviour. To model the relationship between MEEV and the relevant ventilator parameters, a series of clinical trials have been conducted on five (5) ITU patients at the Northern General Hospital, Sheffield, UK. Two modelling techniques (neural networks (NN) and neural-fuzzy) have been applied in order to elicit such relationships which are of a nonlinear nature.

Results

Fig. 2 shows the results of one clinical trial performed on four successive days on the same ITU patient. A decrease in the Peak End-Expiratory Pressure (PEEP) levels leads to decreased lung resistivity and MEEV which agrees with [3].

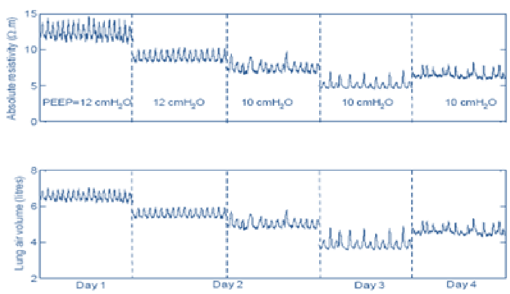

Fig. 2 Lung absolute resistivity and air volume measured by aEIT at different PEEP levels on an ITU patient.

Finally, the clinical exploitation of the models is evaluated by comparing the predicted blood gas information (PaO_2 and $PaCO_2$) obtained from SOPAVent and the regional lung volume information (MEEV) provided by the ANFIS model subject to changes in PEEP settings. Table 1 summarises these results.

Table 1 MEEV, PaO_2 and $PaCO_2$ predicted by the models following PEEP changes.

12.0	4.94	11.56	6.14
11.0	4.87	11.22	5.89
10.0	4.80	10.87	5.67
9.0	4.73	10.53	5.47
8.0	4.67	10.19	5.28

Discussion

Mean end-expiratory lung volume (MEEV) calculated from aEIT is a feature parameter that reveals volume of air present in the lungs at the end of patients' expiration. In this study, increasing PEEP has lead to increase in MEEV (predicted from ANFIS model) and PaO2 (predicted from SOPAVent model). This correlation shows that both models are capable of providing information on patients' lung behaviour in response to ventilation therapy. These sets of information should lead to a better understanding of phenomena surrounding ventilated patients in order to support decision-making and guide ventilator therapy. However, more ventilated patients EIT data are needed to further improve the accuracy of MEEV prediction. Knowledge from experts will also be included in the form of decision rules for suggesting adequate ventilator parameters settings.

References

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