Computer controlled estimation of nonlinear respiratory mechanics using clinically available measurements.

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Introduction:
In clinical practice linear models used to describe respiratory mechanics are often a poor description of pathophysiological processes. To overcome these limitations, this abstract presents a nonlinear respiratory mechanic model, whose parameters can only be identified from complex respiratory patterns. A computer controlled experiment is proposed to identify this model, using only measurements and equipments routinely available in the ICU.

Methods and Results:
The model of respiratory mechanics (figure 1), modified from Barbini et al [1], uses a sigmoid function to describe the nonlinear pressure-volume relationship of both collapsible airways (V_c) and alveolar space (V_a). Airways are modeled as three nonlinear resistances representing upper (R_u), central (R_c), and lower (R_l) airways.

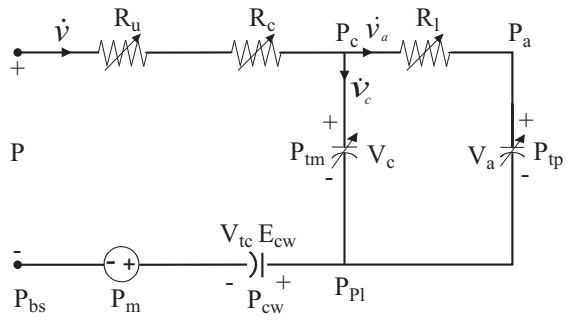

Figure 1 A nonlinear model of respiratory mechanics.

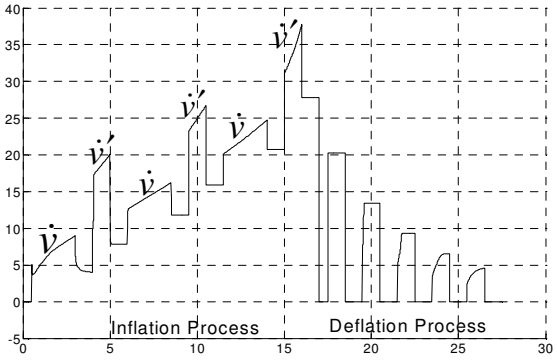

Figure 2 A simulated pressure-time plot illustrating the data necessary to indentify the model

This model has 11 parameters which, assuming a constant chest wall compliance, can be identified from the experiment illustrated in figure 2. A Servo 300 ventilator (Maquet) is computer controlled to deliver inspirations at different constant flows ($\dot{v}$, $\dot{v}'$) with airway occlusions in a long inflation process, and immediately followed by a long passive deflation process consisting of expirations interspersed by occlusions. From pressures and flows measured at the mouth, varying both flow and pressure enables identification of flow, volume and pressure dependant resistances, and placing occlusions at different volumes allows identifying static pressure-volume curves.

Conclusions:
This abstract has presented a computer controlled experiment to identify the nonlinear properties of respiratory mechanics, using only measurements and equipments routinely available in the ICU. Fitting such a complex model may provide a tool for understanding respiratory mechanics and optimizing ventilator settings in the ICU.

Reference:
[1] Barbini, P. Cevenini, G. Avanzolini, G. "Nonlinear Mechanisms Determining Expiratory Flow Limitation in Mechanical Ventilation: A Model-Based Interpretation", Ann Biomed Eng, vol. 31, no. 8, pp. 908-16, 2003