A model for educational simulation of the hemodynamic consequences of severe coughing

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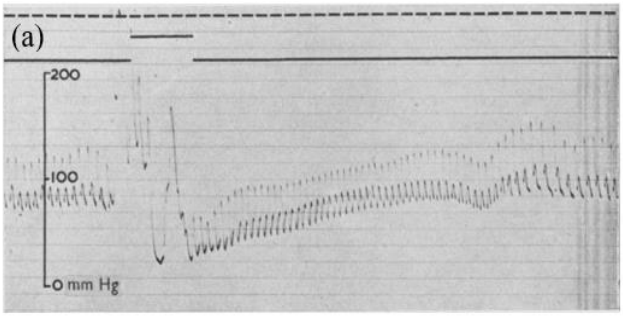
Introduction

Hemodynamic consequences of severe coughing include initial arterial pressure peaks and a post-coughing pressure trough. The former may result in capillary rupture in various organs, the latter in fainting. Therefore, simulation based training in prevention and management of severe coughing seems of interest to a broad range of healthcare professionals. To enable such training, the purpose of the present study is to adapt the cardiovascular model [1] of widely used simulators [http://www.caehealthcare.com/patient-simulators/] so that it can accurately represent the hemodynamic consequences of severe coughing.

Methods

The conceptual model is given in Fig. 1. An intrathoracic pressure profile representing coughing was established, and the model response to it evaluated. After adaptations to improve modeling of near empty vessels, simulation results were obtained and compared to human target data [3].



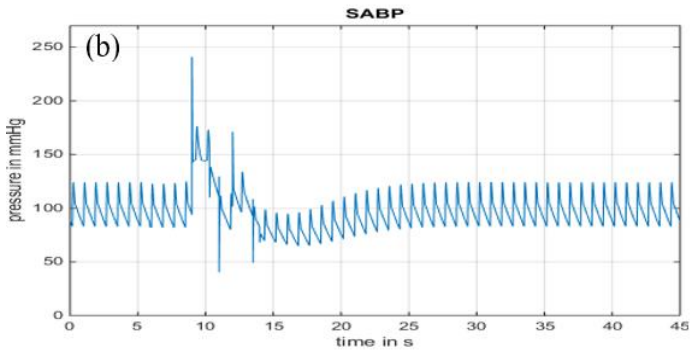


Fig. 2.(a) Systemic arterial blood pressure fluctuations throughout an episode of severe coughing [3] and (b) simulation results.

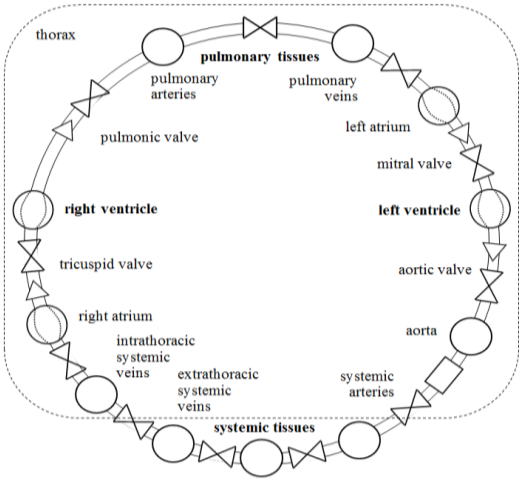


Fig. 1. Component diagram of the cardiovascular model, adapted from [2]

Results

Simulation results match the target data in terms of peak pressures, post-coughing pressure drop and the effect on pulse pressure, Fig. 2. The secondary transient, 20s after the cough, corresponds to currently unmodelled throat-clearing.

Conclusions

We adapted a frequently used cardiovascular model and demonstrated that it can be used to simulate the main hemodynamic effects of severe coughing.

References

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[3] E.P. Sharpey-Schafer EP. "Effects of coughing on intra-thoracic pressure, arterial pressure and peripheral blood flow" *The Journal of Physiology*, vol. 122, 1953, pp. 351-357.
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