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Models of Cheyne–Stokes Respiration with Cardiovascular Pathologies

Cheyne–Stokes respiration is a periodic breathing pattern, characterized by short intervals of deep breathing each followed by an interval of very little or no breathing (known as apnea). This work improves on previous compartmental models of the human cardio-respiratory system that simulate concentration of carbon dioxide in compartments of the cardiovascular system and the lungs. The parameter boundary on which Hopf bifurcation gives birth to a period oscillation has been determined. The models predict that an increase in either the ventilation-perfusion ratio or feedback gain can give rise to stable Cheyne–Stokes oscillations. Physiologically, it is observed that Cheyne–Stokes respiration is more likely to occur in people with pathologies such as chronic heart failure or encephalitis, or in healthy humans during acclimatization to high altitudes or after hyperventilation. Modifications of the model to incorporate these conditions give good agreement with the observations.

This paper is joint with Fang Dong.