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Parameter identifiability of a dynamical system model of breathing in a preterm infant

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The complexity of mathematical models describing breathing mechanics has grown in recent years to integrate with cardiovascular models and incorporate nonlinear dynamics, but has rarely been studied in the context of patient-specific observable data. This study investigates parameter identification of a previously developed nonlinear dynamical system model of breathing in preterm infant (Ellwein Fix et al, 2018), using deterministic sensitivity analysis, subset selection, and gradient-based optimization. The model predicts airflow and dynamic pulmonary volumes and pressures generated under six simulation conditions using 34 characterizing parameters. The combined sensitivity analysis and subset selection methodology produced a subset of 6 independent sensitive parameters identifiable with observable data. Results of optimizations performed using pseudo-data created with varying levels of noise and a data set from literature (Abbasi 1991) demonstrate the feasibility of studying patient-specific infant data with these methods.