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A Computational Model of Variable Chest Wall Compliance in Extremely Preterm Infants

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Non-invasive ventilation (NIV) has become the preferred method of respiratory support for preterm infants. However, infants at gestational age < 26 weeks and birthweight < 750 g often cannot be supported by NIV and are at a high risk of developing chronic lung disease. This has been attributed, in part, to the undermineralization of the ribs and consequent high chest wall compliance that leads to progressive lung collapse as the forces needed to open airspaces after each exhalation become insufficient. Few methods of respiratory support have been aimed specifically at preterm infants, suggesting that a computer model of preterm infant lung mechanics by which the stability of the chest wall could be tested would be of great benefit. To this end we present a lumped parameter pressure-flow model of respiratory dynamics in premature infants that incorporates nonlinear lung and chest wall compliances, lung viscoelasticity, and periodic respiratory activity signal with variable frequency as a function of tidal volume. The model was perturbed by respiratory muscle fatigue, simulated by a gradual decrease in signal amplitude. Results demonstrate a faster loss of lung volume under high chest wall compliance conditions, consistent with clinical observations.