Role of Mechanical Stress in Optimising Breathing Therapy Humidification

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During breathing therapy, heated humidification is often used to condition inhaled air and minimise symptoms associated with airway drying. The current treatment paradigm is based on providing the patient with fully humidified air at core body temperatures in an attempt to eliminate the need for the heat or moisture provided or recovered during normal breathing. Although this approach seems to reduce both the occurrence and severity of symptoms, supplementary humidification exposes the airway to additional risks such as excess fluid levels and thermal damage. The ability of the epithelial cells to regulate airway fluid volume during breathing at elevated pressures and the effect supplementary pressure has on the mucociliary transport velocity require an in-depth investigation. The purpose of this study is to quantify the appropriate level of supplementary humidification required for a given pressure augmentation. An appropriate biophysical model, which describes the nose air-conditioning during breathing therapies involving augmented pressures, will be developed. Data from clinical trials, laws of mass and heat transfer will be used to develop the model. The proposed model will incorporate the regulation of airway fluid supply which is partially controlled through the simulation of the epithelial cell stress induced during tidal breathing. This will enable prediction of the optimum heat and humidification supplementation required to make up for the dynamic state of mucosa dysfunction encountered. The physiological benefits in matching supplementary humidification to mucosa state of dysfunction include maintenance of normal airway fluid volume within the upper airway and preservation of healthy mucociliary clearance through prevention of inflammation caused by fluid imbalances or thermal injury.