Micropatterned Endotracheal Tubes Reduce Secretion-Related Lumen Occlusion

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Abstract

Tracheal intubation disrupts physiological homeostasis of secretion production and clearance, resulting in secretion accumulation within endotracheal tubes (ETTs). Novel *in vitro* and *in vivo* models were developed to specifically recapitulate the clinical manifestations of ETT occlusion. The novel Sharklet™ micropatterned ETT was evaluated, using these models, for the ability to reduce the accumulation of both bacterial biofilm and airway mucus compared to a standard care ETT. Novel ETTs with micropattern on the inner and outer surfaces were placed adjacent to standard care ETTs in *in vitro* biofilm and airway patency (AP) models. The primary outcome for the biofilm model was to compare commercially-available ETTs (standard care and silver-coated) to micropatterned for quantity of biofilm accumulation. The AP model's primary outcome was to evaluate accumulation of artificial airway mucus. A 24-h ovine mechanical ventilation model evaluated the primary outcome of relative quantity of airway secretion accumulation in the ETTs tested. The secondary outcome was measuring the effect of secretion accumulation in the ETTs on airway resistance. Micropatterned ETTs significantly reduced biofilm by 71% ($p = 0.016$) compared to smooth ETTs. Moreover, micropatterned ETTs reduced lumen occlusion, in the AP model, as measured by cross-sectional area, in distal (85%,$p = 0.005$), middle (84%, $p = 0.001$) and proximal (81%, $p = 0.002$) sections compared to standard care ETTs. Micropatterned ETTs reduced the volume of secretion accumulation in a sheep model of occlusion by 61% ($p < 0.001$) after 24 h of mechanical ventilation. Importantly, micropatterned ETTs reduced the rise in ventilation peak inspiratory pressures over time by as much as 49% ($p = 0.005$) compared to standard care ETTs. Micropatterned ETTs, demonstrated here to reduce bacterial contamination and mucus occlusion, will have the capacity to limit complications occurring during mechanical ventilation and ultimately improve patient care.