Superhydrophobic, nanotextured polyvinyl chloride films for delaying *Pseudomonas aeruginosa* attachment to intubation tubes and medical plastics

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1. Introduction

Polymer–based medical devices such as endotracheal tubes and catheters are indispensable for the treatment of critically ill patients. Indeed, it was estimated that in the US alone, ~20 million urinary catheters are used annually [1]. Therefore, the high incidence of infection associated with the use of these medical devices is of grave concern. For instance, endotracheal tubes inserted into patients who need mechanical ventilation, bypass the body’s primary host defenses, and provide initial sites for bacterial colonization. When intubated for prolonged periods, these colonies are capable of developing into life-threatening biofilm-based infections. Statistics have shown that ventilator-associated pneumonia (VAP), a common hospital-acquired infection, affects up to 28% of patients who use endotracheal tubes for ventilation [2]. *Pseudomonas aeruginosa* and *Staphylococcus aureus* are often responsible for such endotracheal tube associated infections with 41.7% and 36.7%, respectively, of VAP cases being attributed to these microorganisms [3]. Due to the high morbidity rate (24–50%) of VAP [4], work has focused on the design of endotracheal tubes with higher resistance and/or delayed bacterial colonization. By increasing the time for initial bacterial adhesion and proliferation, VAP may be significantly reduced since infection is highest in the early days of intubation: ~3% infection/day for the first 5 days of intubation, decreasing to 2% per day between day 5 to day 10 [5].

To reduce bacterial colonization and infection, several modifications to endotracheal tubes have been studied. These include modifying inflatable cuffs that provide a physical barrier to prevent secretions from trachea from flowing into the lungs [6,7], and immobilization of antimicrobial agents onto the tube surface. For example, Roe et al. reported that the impregnation of 600 μg of silver nanoparticles into an endotracheal tube was sufficient to inhibit both growth and biofilm formation of *Escherichia coli* and *S. aureus* for more than 72 h [8]. In another study, the release of zinc oxide nanoparticles from polyvinyl chloride (PVC)-based endotracheal tubes resulted in at least a 50% reduction in *S. aureus* biofilm formation [9].

It is believed that initial contact of microorganisms with the surface of materials is crucial for successful colonization [10]. The interactions between the microorganism and material are