Improved Endotracheal Tubes for Prevention of Ventilator-Associated Pneumonia: Better Than Silver and Gold?

Recently, the use of noninvasive ventilation and nasal high-flow oxygen has increased, resulting in a substantial decrease in the number of intubated critically ill patients. However, a large proportion of mechanically ventilated patients still require invasive ventilation and are exposed to complications, including ventilator-associated pneumonia (VAP).[1] Recent advances in pathophysiology and prevention of VAP have resulted in important reductions in its incidence, but the incidence of this infection is still high, especially in patients who receive prolonged mechanical ventilation.[2] VAP is associated with a high mortality rate, prolonged mechanical ventilation, longer ICU length of stay, and higher costs.[3]

Microaspiration of either gastric contents or oropharyngeal secretions is the main mechanism responsible for the entry of bacteria into the lower respiratory tract in intubated patients. When the quantity of aspirated bacteria is high, tracheobronchial colonization may progress into ventilator-associated tracheobronchitis and VAP. In addition to factors related to the endotracheal tube (ETT), risk factors for microaspiration in intubated critically ill patients include conditions related to enteral nutrition, mechanical ventilation, and patient comorbidities.[4]

Biofilm formation on the ETT also plays an in important role in the pathogenesis of lower respiratory tract infections.[5] Biofilms develop rapidly after an ETT is placed and represent a persistent source of bacteria in intubated critically ill patients. The volume of biofilm increases with the duration of intubation. Invasive procedures such as fiberoptic bronchoscopy and ETT suctioning may fragment some parts of the biofilm, which can progress into the distal respiratory tract with the inspiratory flow.[6] Previous studies have clearly demonstrated the presence of bacteria responsible for VAP in ETT biofilm.[7] However, it is still difficult to identify whether the biofilm was the source of these bacteria, or if their presence in the biofilm is an independent phenomenon. Biofilm has also been reported to be a source for recurrent VAP, especially episodes related to multidrug-resistant bacteria.[6]

Better understanding of VAP pathophysiology is a key component to improving preventive strategies, and important progress has been made in the prevention of microaspiration and biofilm in intubated critically ill patients.[8]

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Regarding microaspiration, subglottic secretion drainage, continuous control of ETT cuff pressure, polyurethane-cuffed ETTs, and conical-shaped ETT cuffs are the primary measures investigated during the last decade. Encouraging results have been obtained on the role of subglottic secretion drainage and continuous control of cuff pressure on VAP incidence.[9,10] However, conical ETT cuffs have shown no significant impact on microaspiration or VAP incidence,[11] and interest in using polyurethane-cuffed ETTs requires further investigation.[12]

Few clinical studies have evaluated the impact of strategies aimed at preventing or removing biofilm in intubated critically ill patients. The large, randomized, controlled, multicenter NASCENT study[13] aimed to evaluate the impact of silver-coated ETTs compared with uncoated ETTs on VAP incidence. The use of silver-coated ETTs significantly reduced the incidence of VAP and time to VAP occurrence. However, the beneficial effect was only observed during the first 10 d of mechanical ventilation. A recent Cochrane meta-analysis did not confirm these results, and the authors reported that silver-coated ETTs had no significant impact on VAP incidence.[14] Berra and colleagues[15] performed a single-center, randomized, controlled study to evaluate the impact of the Mucus Shaver, a device designed to remove secretions from the ETT, on biofilm formation and colonization. Although biofilm volume and rate of colonization were significantly lower in intervention group, no significant difference was found in VAP rate or other subject outcomes.

In this issue of RESPIRATORY CARE, Pirrone and colleagues[16] report the results of a randomized, controlled, single-center study that aimed to evaluate the combined effect of silver-coated ETTs and cleaning of the ETT with an expandable wiper similar to the Mucus Shaver on the incidence of colonized ETTs. Thirty-nine subjects were randomized to receive the combined intervention or only silver-coated ETTs (19 subjects received the intervention, and 20 subjects served as controls). No significant difference was found in the percentage of positive ETT cultures or in

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bacterial load. Decreased biofilm deposition was observed in the intervention group, but the difference did not reach statistical significance. The authors should be congratulated for having designed and conducted this interesting study evaluating a novel concept. In fact, one of the explanations suggested for the absence of a prolonged effect of the silver coating in the NASCENT study[13] was that the formation of biofilm might have prevented the silver from eradicating bacteria. Thus, it is logical to combine the 2 measures as in the study by Pirrone and colleagues.[16] As clearly acknowledged by the authors, the absence of a statistically significant impact of the combined intervention could be related to the small number of subjects studied. Another explanation could be the fact that only biofilm prevention was targeted in this study, and no specific measures were used to reduce microaspiration of gastric and oropharyngeal secretions. As previously highlighted, the use of bundles gathering several preventive measures aiming at preventing microaspiration and biofilm should be evaluated.[17]

In addition to removing biofilm or preventing its development through the use of silver-coated ETTs, another interesting perspective regarding biofilm prevention is the modulation of host response.[18] Quorum-sensing inhibition or quenching, augmentation of host response, inhibition of cyclic diguanosine monophosphate, or antibiofilm peptides and molecules are being investigated to prevent biofilm formation.[19] In a pilot experimental study, a single dose of poly-L-lysine K was able to immediately disrupt the biofilm structure and kill > 90% of bacteria present in the biofilm in ETTs coming from intubated critically ill patients. Future research in this field is clearly warranted in intubated critically ill patients.[20] Large randomized controlled studies should also be performed to determine whether the combination of silver-coated ETTs and devices such as the Mucus Shaver are better than silver and gold for VAP prevention.

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