Tracheal Cuff Management as Part of a Lung-Protective Strategy

Complications associated with mechanical ventilation have been extensively described in the literature in the last 3 decades.¹ From ventilator-induced lung injury to ventilator-induced diaphragmatic dysfunction more recently defined, numerous side effects directly or indirectly related to mechanical ventilation have been identified. As a consequence, so-called lung-protective ventilation could be theoretically not limited to optimal ventilator settings but rather include prevention of complications occurring from intubation to extubation.

Along this line, great attention has been paid to tracheal cuff management in recent literature.^{2,3} Excessive cuff pressure may cause severe ischemic damage to the tracheal mucosa, potentially leading to granuloma, stenosis, or necrosis, whereas insufficient pressure and sealing may favor aspiration and promote ventilator-associated pneumonia.^{4,5} Maintaining tracheal cuff pressure in an optimal range is therefore recommended and should be considered as an important part of a global protective ventilator strategy.

In a large prospective randomized study enrolling 450 subjects mechanically ventilated for elective cardiopulmonary artery bypass grafting, Bolzan et al⁶ compared 2 strategies of tracheal cuff pressure management aiming to prevent complications associated with excessive cuff pressure. The strategy previously described and tested by the authors is based on the analysis of the volume-time curve to detect leaks occurring around the tracheal tube when the cuff is not sufficiently inflated.⁷ The authors used a specific device designed for respiratory mechanics assessment (Ventcare 9505 VSF, Takaoka, São Paulo, Brazil). Compared with a clinical approach based on manual stepwise cuff inflation guided by leak sound abolition, their original volume-time curve technique significantly reduced the incidence and severity of a number of postextubation symptoms prospectively defined, including sore throat, cough episodes, and thoracic pain, at 1 and 24 h

after extubation. The extremely short duration of ventilation in this series did not justify an assessment of infectious complications.

Because the volume-time curve technique aimed, by design, to maintain the minimal pressure to avoid leaks, we expected lower cuff pressure with this approach, as shown previously by the authors. Cuff pressure measured in the group managed with the volume-time curve was indeed significantly lower compared with that in the control group, but surprisingly, it remains in a relatively high range (~31 vs 38 cm H₂O) compared with previously reported measures and current recommendations. This may be due to a tendency to overinflate the cuff to completely avoid leaks. Considering that cuff pressure should not exceed 30 cm H₂O and rather be maintained at ~25–27 cm H₂O to preserve tracheal blood perfusion and avoid ischemia, this result could be viewed as a limit of the

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technique.⁸ For these reasons, extension of the present conclusions to patients ventilated for longer duration may be hazardous. Numerous alternative technical solutions have been proposed and tested for this purpose.⁴ Each technique presents advantages and limitations inherent to its own working principle. To date, evidence suggests that automatic devices allowing a continuous control of cuff pressure are more efficient than iterative controls to prevent complications associated with subglottic aspiration^{9–11}

Several automatic systems, either pneumatic or electronic, are available today. These systems work by controlling cuff pressure according to a predefined target usually between 20 and 30 cm H₂O. Pneumatic systems seem very efficient in preventing insufficient pressure.^{8,11,12} This may be favored by the time constant of the system's response that limits overcompensation (deflation) from occurring when tracheal pressure increases rapidly.¹³ Moreover, by design, pneumatic systems limit overcompensation (cuff deflation) in the case of high pressure because regulation is based on a transfer of gas into the system rather than allowing cuff deflation and thus imposing iterative inflation procedures.

In a bench study, Weiss et al¹³ suggested that cuff pressure should ideally follow airway peak inspiratory pressure to ensure sealing around the tracheal tube cuff during

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Correspondence: Jean-Christophe M Richard MD PhD, Department of Pre-Hospital and Emergency Medicine, General Hospital of Annecy, Annecy, France. E-mail: jcmr.richard@gmail.com.

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ventilation. Although not validated clinically, this approach is available today on some ventilators (Intellicuff, Hamilton Medical, Reno, Nevada). Nevertheless, this interesting concept may result in high cuff pressure in severely ill patients exhibiting high plateau and peak pressure. To limit this shortcoming, a maximal pre-set cuff pressure can be set on the Intellicuff's interface. Alternatively, to direct cuff management, the use of a ventilatory mode based on decelerating flow may advantageously limit maximal pressure and leaks around the tracheal tube. Both the risk associated with tracheal aspiration and the risk of high cuff pressures are real concerns in critically ill patients due to their vulnerability in terms of infectious complications and tracheal ischemia and the duration of mechanical ventilation.

The volume-time curve leak analysis tested by Bolzan et al⁶ is an interesting alternative technique that could theoretically be associated with a traditional cuff pressure target method to optimize the control of cuff inflation. Experimental studies showed that cuff pressure may vary widely during mechanical ventilation, and the ideal cuff pressure range is difficult to define, depending on tracheal tube size and airway pressure regime.^{8,13}

A new technological approach to control tracheal tube sealing while limiting cuff pressure should be developed. This is particularly important for prolonged mechanical ventilation and most severely critically ill patients. Tracheal cuff management is a good example of emerging technological challenges necessary to face new clinical evidences.

Jean-Christophe M Richard MD PhD

Department of Pre-Hospital and Emergency Medicine
General Hospital of Annecy
Annecy, France

Alain Mercat MD PhD

Department of Intensive Care and Hyperbaric Medicine
University Hospital of Angers
Angers, France

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