ume ventilation in burns: a randomized controlled trial. Crit Care Med 2010;38(10):1970-1977.
14. Allan PF, Thurlby JR, Naworol GA. Measurement of pulsatile tidal volume, pressure amplitude, and gas flow during high-frequency percussive ventilation, with and without partial cuff deflation. Respir Care 2007;52(1):45-49.
15. Dries DJ, Marini JJ. Airway pressure release ventilation. J Burn Care Res 2009;30(6):929-936.
16. Kenney BD. Airway pressure-release ventilation. Respir Care 2007;54(4):452-458.
17. Byerly FL, Cairns BA, Short KA, Haithcock JA, Shapiro L, Page A, Boysen P. High frequency percussive ventilation can mimic airway pressure release ventilation in a test lung model (abstract). Crit Care Med 2004;32(12):A38.
18. Hall JJ, Hunt JL, Arnoldo BD, Purdue GF. Use of high-frequency percussive ventilation in inhalation injuries. J Burn Care Res 2007;28(3):396-400.
19. Hurst JM, Branson RD, Davis K Jr. High-frequency percussive ventilation in the management of elevated intracranial pressure. J Trauma 1988;28(9):1363-7136.
20. Cioffi WG, Graves TA, McManus WF, Pruitt BA Jr. High-frequency percussive ventilation in patients with inhalation injury. J Trauma 1989;29(3):350-354.
21. Peck M, Harrington D, Mlcak RP, Cartotto R. Potential studies of mode of ventilation in inhalation injury. J Burn Care Res 2009;30(1):181-183.
22. Fessler HE, Hager DN, Brower RG. Feasibility of very high frequency ventilation in adults with acute respiratory distress syndrome. Crit Care Med 2008;36(4):1043-1048.
23. Derdak S. Lung-protective higher frequency oscillatory ventilation. Crit Care Med 2008;36(4):1358-1360.
24. Allan PF, Osborn EC, Chung KK, Wanek SM. High-frequency percussive ventilation revisited. J Burn Care Re 2010;31(4):510-520.
25. Salim A, Martin M. High frequency percussive ventilation. Crit Care Med 2005;33(3 Suppl):S241-S245.
26. NHLBI Acute Respiratory Distress Syndrome Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute respiratory distress syndrome. N Engl J Med 2000;342(18):1301-1308.

In Vitro Fluid Leak Around the Endotracheal Tube Cuff Is Easily Remedied

In the August 2010 issue of RESPIRATORY CARE, Deem and Treggiari reviewed the current evidence regarding endotracheal tube (ETT) design and the incidence of ventilator-associated pneumonia.[1] This letter is in regards to polyurethane-cuffed ETTs and seepage of secretions into the tracheobronchial tree. The theoretical advantage of polyurethane and silicone cuffs, compared to high-volume low-pressure polyvinyl chloride (PVC) cuffs, is the absence of creases on the inflated cuff surface, which can allow secretions to pass into the tracheobronchial tree, thereby increasing the incidence of ventilator-associated pneumonia. Deem and Treggiari gave an overview of the few clinical studies that have been performed, and pointed out some inadequacies in the current body of knowledge. I agree with them that more clinical studies are needed to better assess the efficacy and cost-effectiveness of polyurethane and silicone cuffs.

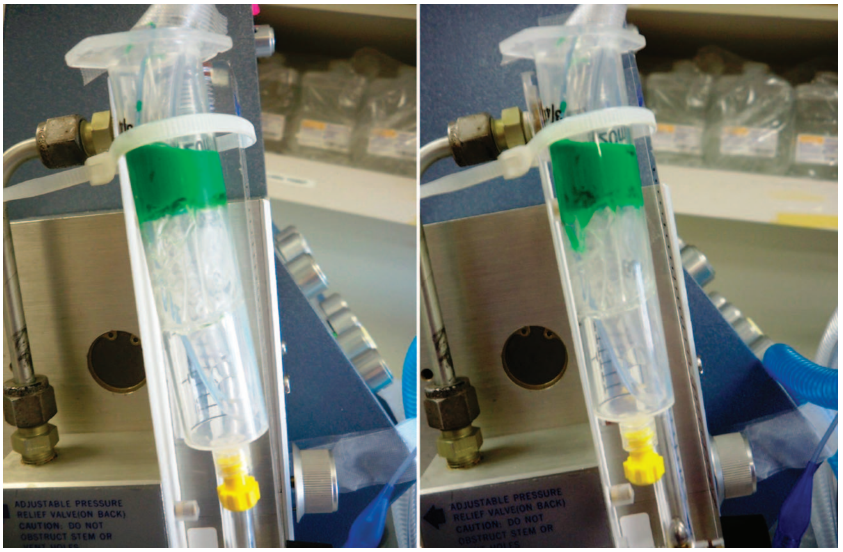

Fig. 1. Left: Mallinckrodt 7.5-mm inner-diameter endotracheal tube with a lubricated PVC cuff, 2 hours after 3 mL of colored whole milk was instilled above the cuff and the model was mechanically ventilated at 5 cm H_2O PEEP and 5 cm H_2O inspiratory pressure (ie, pressure below the cuff). Immediately after taking this picture, I agitated the cuff by moving the endotracheal tube up and down and side to side. Right: Three hours later (2 hours after agitating the cuff plus 1 hour after disconnecting the ventilator and thus removing the positive pressure below the cuff).

Included in Deem and Treggiari's paper were 2 photographs from an in vitro study, depicting the theoretical advantage of polyurethane cuffs. Dye was instilled on the top of a cuff inflated inside a plastic tube. After 15 minutes all of the dye had leaked past the PVC cuff, whereas none had leaked past the polyurethane cuff. They say a picture is worth a thousand words, and these pictures certainly are remarkable and I would expect them to be very influential on clinicians. It is obvious from the text that Deem and Treggiari did not use these photographs in an attempt to convince the reader that polyurethane cuffs should replace PVC cuffs; however, these photographs do exaggerate the superior in vitro performance of polyurethane cuffs, given that leakage around a PVC cuff in vitro is easily remedied.

Dullenkopf et al[2] performed an in vitro study like the one described above, and found that after 10 min nearly all the fluid had passed by the PVC cuff, whereas none had leaked past the polyurethane cuff. However, when they treated the PVC cuff with a lubricating gel, leakage was substantially reduced. Lucangelo and colleagues[3] also performed a similar in vitro experiment, and found that PEEP of 5 cm H_2O essentially eliminated seepage around the PVC cuff, both in vitro and in vivo.

I performed a similar in vitro experiment (unpublished) with a couple of other modifications. I used a Mallinckrodt 7.5-mm inner-diameter ETT with a PVC cuff, inserted into a 30-mL syringe that has the same diameter (20 mm) as the average human adult trachea.[4] I lubricated the PVC cuff with a water-soluble jelly prior to insertion. Given that oropharyngeal secretions have a higher viscosity than water, I used colored whole milk, which at 70°F has a viscosity 2–3 times higher than water. I applied PEEP 5 cm H_2O, inspiratory pressure 5 cm H_2O, respiratory rate 10 breaths/min, and inspiratory time 0.9 s, to more closely simulate mechanical ventilation. There was no leakage past the cuff after 2 hours (Fig. 1). After taking the first photograph in Figure 1, I agitated the cuff within the syringe by moving the ETT up and down and side to side. A small amount of the colored milk seeped into a few of the cuff creases, but after 2 more hours of mechanical ventilation, none of the colored milk had even made it to the middle of the cuff. Two hours after agitating the cuff (ie, at the 4-hour mark) I disconnected the ventilator, and 1 hour later none of the dyed milk had leaked past the cuff (see Fig. 1).

There are, of course, other issues that may affect cuff performance, such as the maintenance of cuff pressure,[5] cough, tracheobronchial suctioning, the limited protection from cuff lubrication, the interface with a natural trachea, and the impact of other concomitant ventilator-associated-pneumonia prophylactic measures. That being said, I think that photographs depicting superior in vitro cuff leak protection from a polyurethane cuff (under ambient pressure, with a low-viscosity liquid, and without cuff lubrication) project an exaggerated view of how polyurethane cuffs might outperform PVC-cuffed ETTs in patients.

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REFERENCES

1. Deem S, Treggiari MM. New endotracheal tubes designed to prevent ventila-tor-associated pneumonia: do they make a difference? Respir Care 2010;55(8):1046-1055.
2. Dullenkopf A, Gerber A, Weiss M. Fluid leakage past tracheal tube cuffs: evaluation of the new Microcuff endotracheal tube. Intensive Care Med 2003;29(10):1849-1853.
3. Lucangelo U, Zin WA, Antonaglia V, Petrucci L, Viviani M, Buscema G, et al. Effect of positive expiratory pressure and type of tracheal cuff on the incidence of aspiration in mechanically ventilated patients in an intensive care unit. Crit Care Med 2008;36(2):409-413.
4. Breatnach E, Abbott GC, Fraser RG. Dimensions of the normal human trachea. AJR Am J Roentgenol 1984;142(5):903-906.
5. Nseir S. Does polyurethane impact endotracheal pressure? Crit Care Med 2008; 36(7):2219-2220.