Some Comments On the Cuff

This issue of RESPIRATORY CARE includes a detailed study of a novel device to maintain a stable pressure within the cuff of an endotracheal tube (ETT).[1] Why all the bother? Why do ETTs need cuffs anyway? These seem like silly questions on the surface. A certain level of occlusion between the tracheal wall and the ETT is necessary for positive-pressure ventilation. But what level of occlusion is appropriate and what level of seal is necessary?[2] Another reason for the cuff is to reduce the aspiration of secretions and the occurrence of ventilator-associated pneumonia. But certainly not all patients should need to have their tracheas tightly corked to prevent pneumonia.[3] Other strategies, such as the use of a supraglottic airway or noninvasive ventilation, might be equally effective or better.

SEE THE ORIGINAL STUDY ON PAGE 1506

The ETT cuff also has its own risks. History has documented a litany of severe injuries, including erosion through tracheal rings and vascular structures, and even death.[2,4-6] Newer cuff designs have reduced but not eliminated the incidence of such injuries. Mucosal trauma can be documented even when intubation is brief and cuff pressure is within reason.[7] Stepping back a bit, how can we achieve the goals of providing mechanical ventilation and protecting the airway from aspiration while minimizing the trauma associated with endotracheal intubation and a cuffed ETT?

Howard designed a device that constantly measures and maintains the inflation of the ETT cuff within a specified range. This approach counts on the idea that high cuff pressure should be avoided to reduce mucosal injury, but that a certain minimum pressure is needed to reduce the risk of aspiration.[3] As clinicians we are pretty bad at accomplishing this task.[8] Cuff pressures vary considerably, and we aren't very good at determining what the cuff pressure is by feeling the cuff's pilot balloon or attempting to inflate the cuff only to a minimally occlusive volume.[9-12]

Routinely measuring cuff pressure has been recommended, and manometers are widely available, although variably accurate.[13,14] The mere act of inserting and disconnecting a manometer into the pilot balloon valve can reduce the pressure within the cuff (just like I do when I attempt to measure my car's tire pressures—I always seem to let out some of the air). More clever devices to monitor and maintain cuff pressure within a specified range have been designed,[15,16] but none of these devices seems to have gained much popularity. Some are quite cumbersome.[16,17] Others, such as Howard's, require a continuous connection to a pressurized gas source, which limits patient mobility and adds complexity to patient care.[18,19] It is also unclear whether such devices will work well in changing clinical situations and whether closely regulating cuff pressure will actually reduce the risks of intubation.

Given the reality of pneumatic cuffs, several approaches might be explored to simply monitor and control cuff inflation. Let's return for a moment to my automobile tires. It is now federally mandated that all new cars will be equipped with a tire pressure monitoring system that electronically measures and reports inflation pressure to the driver.[20] Similar electronic systems might be adapted for measuring cuff pressure, which then could be reported to the patient's mechanical ventilator or monitor and alert the practitioner to an abnormal pressure. If desired, a pressurized gas line from the ventilator might be used to automatically adjust cuff pressure. This is not a new concept.[18]

But must we accept current designs of pneumatic cuffs on ETTs? Alternative cuff designs and materials have been evaluated, and some may be promising.[21-23] Newer is not always better, however. Latex cuffs, for example, had mechanical properties that reduced the consequences of overinflation, compared to polyvinylchloride cuffs.[24] Ease of manufacture and cost are constant trade-offs to safer design.

Clearly, this issue isn't solved. Some innovators are working to reduce or completely eliminate the need for the ETT. Noninvasive ventilation is widely used and spares many patients from endotracheal intubation. Supraglottic airway devices that avoid creating a seal within the trachea are also commonplace, but create other complications that generally prevent their use for more than a few hours. Negative-pressure ventilation avoids endotracheal intubation and has been used for more than half a century, but remains limited in its application and practicality. Alternative patterns of positive-pressure ventilation, such as transtracheal open ventilation, have been explored, which interfere minimally with glottic function and do not require a cuffed ETT.[25,26] Novel strategies, such as lateral positioning and reduction of biofilm formation within the ETT, might also reduce the incidence of ventilator-asso-

ciated pneumonia without requiring a highly pressurized cuff.[27,28]

The study by Howard[1] provides us with one innovative approach to controlling cuff pressure, in hopes of reducing complications while providing mechanical ventilation. Additional approaches and further innovation are needed. Tracheal injuries still occur frequently, and aspiration pneumonias continue to occur despite conservative measures such as head-of-bed elevation and supraglottic suctioning. We need to continue work on thoughtful approaches and intelligent solutions to these issues.

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