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Monitoring Tracheal Tube Cuff Pressures in the ICU Can Prevent Injury

From: [ENT Today, September 2007](#)

by Jennifer Decker Arevalo, MA

“Despite increasing awareness among intensivists and respiratory therapists and more widespread use of low-pressure, high-volume cuffs, the incidence of tracheal tube cuff overinflation remains high in the contemporary American intensive care unit [ICU],” said Luc Morris, MD, from the Head and Neck Service in the Department of Otolaryngology at New York University School of Medicine during his scientific session presentation at the April 2007 meeting of the American Broncho-Esophagological Association at the Combined Otolaryngology Spring Meeting.

“This is a public health issue that otolaryngologists need to take the lead in,” continued Dr. Morris, whose paper was published in the August *Annals of Otolaryngology, Rhinology, and Laryngology*. “We are the airway doctors who take care of these patients when they come to us short of breath with tracheal stenosis, long after they have left the ICU. Every day, a large percentage of intubated and tracheotomized patients in our hospitals are experiencing tracheal injury. We have put the responsibility of preventing this problem on the shoulders of practitioners who are busy with other issues, and who have a hard time prioritizing this issue, because they do not see the sequelae of high cuff pressures.”

Prolonged intubation with cuffed tracheal tubes is common in ICU patients requiring mechanical ventilation. Although perioral endotracheal tubes are routinely converted to tracheotomy tubes, both types of cuffed tubes exert pressure against tracheal mucosa. Cuff pressure is a recognized risk factor for tracheal injury and subsequent tracheal stenosis.¹⁻⁴ Although international studies report a 55% to 62% incidence of cuff overinflation among ICU patients,^{5,6} there are no data on tracheotomy tubes and no recent data from ICUs in the United States.

Auditing Cuff Pressure

To track the incidence of tracheal tube cuff overinflation and determine whether routine cuff pressure measurement is beneficial, Dr. Morris and his colleagues performed a three-month, prospective, observational study of 115 patients who had endotracheal or tracheotomy tubes. The study was conducted at two US tertiary-care academic hospitals, which monitor cuff pressure differently.

At Hospital A, respiratory therapists routinely assessed cuff pressures by palpation, but not by direct measurement, once during every 12-hour shift. At Hospital B, cuff pressures were measured with a manometer every one to two days and were informally palpated on every shift. At both hospitals, inappropriately inflated cuffs were adjusted promptly.

“We audited cuff pressures in an unannounced fashion at these hospitals at various times across daytime hours, without regard to the timing of the respiratory therapists' rounds,” said Dr. Morris. A handheld aneroid manometer was used to measure cuff pressures via the pilot balloon, taking care not to create an air leak during measurement. If cuff pressure varied from inspiration to expiration, the mean value was recorded.



Luc Morris, MD

“Cuffs were considered overinflated above 25 cm of water,” continued Dr. Morris. “This can lead to tracheal injury, such as ciliary loss and mucosal injury to the basement membrane, in as little as two hours after intubation.” In this study, 44 cuffs (38%) were overinflated and 22 cuffs (19%) were severely overinflated (>40 cm H₂O).

At Hospital A, 24 of 63 cuffs (38%) were overinflated and at Hospital B, 20 of 52 cuffs (38%) were overinflated. “Surprisingly, there was absolutely no difference in rates of overinflation between the two hospitals,” said Dr. Morris, even though studies have suggested that manometry is a more reliable method of cuff assessment than digital palpation.

This may be due to several factors. Members of the health care team may have readjusted the cuffs when they responded to ventilator alarms, perceived air leaks, or concern for aspiration. Additionally, cuff pressures might have changed throughout the day, as the tube migrated with patient repositioning or suctioning or because of air leaking out of the cuff. This may have led to increased or decreased cuff pressure, which might have triggered an air leak alarm and lead to further inflation by a physician or nurse.

Mean cuff pressures were 26.2 cm H₂O (median, 22.0 cm H₂O) at Hospital A and 25.3 cm H₂O (median, 21.0 cm H₂O) at Hospital B. Among endotracheal tubes, 29 of 68 (43%) were overinflated, compared with 15 of 47 (32%) of tracheotomy tubes. The mean orotracheal tube cuff pressure was 27.0 cm H₂O and the mean tracheotomy tube cuff pressure was 24.0 cm H₂O, indicating that both are equally likely to be overinflated. There was also no difference in rates of severe overinflation.

“This study reports a 38% incidence of overinflation,” said Dr. Morris. “While this number is slightly lower than those from international studies, it remains high and reflects a significant number of patients in our institutions’ ICUs at risk for tracheal injury.”

Strategies for Improving Outcomes

Possible strategies for improvement in outcomes include more frequent manometric assessment by trained respiratory therapists, since cuff pressures change and tubes are adjusted throughout the day, and education of physicians and nurses on cuff pressure management and sequelae of overinflation.

As the use of manometry to assess cuff pressures did not reduce the incidence of overinflation in this study, Dr. Morris suggested that a more vigilant management protocol, which also monitors tracheotomy tubes, may be necessary. “Most hospitals have protocols for the monitoring of tracheal tube cuff pressures and most respiratory therapists and critical care specialists—especially anesthesiologists—are very aware of this issue, even though they may not have received formal training in the subject. Ironically, nobody has ever attempted to determine if these protocols actually work and we should, at the very least, periodically assess whether their protocols are meeting the desired targets,” said Dr. Morris.

Continuous pressure monitoring and readjustment devices are in development. “The most promising development is new endotracheal and tracheotomy tubes with polyurethane foam cuffs which self-inflate to very low pressures, while still protecting against leakage of secretions,” said Dr. Morris. “We assume, although it hasn't been studied, that these foam cuffs are less likely to injure the trachea.”

There are also endotracheal tube cuffs that have been designed with pressure relief valves that activate at 40 cm H₂O. These self-regulating cuffs would be useful in limiting inadvertent overinflation, as well as intraoperative pressure increases with nitrous oxide.

“The main attraction of these technologies is that they would not require constant human intervention to maintain the cuff pressures, which is the main obstacle,” said Dr. Morris, “but unfortunately, they are not widely available right now.”

Until the technology arrives, “our role as airway specialists is to not only to diagnose and treat, but also to try to prevent this problem by developing hospital-wide respiratory care protocols, optimising tracheotomy care and educating other health care professionals about the risk factors of overinflated tracheal tube cuffs.”

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