Limited Value of the Cuff-Leak Test

Stridor following tracheal extubation occurs in approximately 5% of all patients, and approximately 1% of all patients require reintubation for upper-airway obstruction.[1] Patients at increased risk for stridor and upper-airway obstruction following extubation include female patients; children,[2] particularly those with acute respiratory-tract infections (croup);[3] patients who have incurred facial or airway trauma or burns or who have undergone surgery of the head and neck; patients with head and neck malignancies, goiters, or other masses;[4] and patients with airway edema due to allergic reactions or massive volume resuscitation. The duration of intubation also plays a role in the likelihood of postextubation stridor, with approximately 7% of patients intubated for longer than 36 hours developing stridor, compared to approximately 1% of those intubated for less than 36 hours.[1]

The ability to predict which patients will require an escalation of care because of stridor following extubation, possibly culminating in re-intubation, is an obviously desirable goal. Beyond assessment of risk factors, clinicians have long used the so-called "cuff-leak" test to predict postextubation airway patency, wherein the endotracheal tube cuff is deflated and a leak of air around the tube is sought during either spontaneous ventilation (with the endotracheal tube lumen occluded) or positive-pressure ventilation.[5] Early reports on the cuff-leak test with intubated children suggested that the presence of an air leak was associated with a low likelihood of clinically important postextubation stridor, whereas the absence of a leak was associated with a high incidence of stridor and re-intubation.[2,3] However, later studies with adult patients found that the positive predictive value (true positive tests divided by total positive tests) of the qualitative cuff-leak test was poor; two thirds of patients who did not have a cuff leak did not have clinically important postextubation stridor.[4,6] Both of these studies were small, with a total of only 16 patients who did not have a cuff leak.

Quantification of the cuff leak by reporting the "leak volume" (inspired minus exhaled tidal volume during positive-pressure ventilation) or the fraction of leak volume (inspired minus exhaled volume divided by inspired tidal volume) has been reported to improve on the original, qualitative test, although, again, in small studies with few patients having no or small cuff leaks.[7–9] Furthermore, in the largest study to date that used cuff-leak quantification ($n = 524$, 20 of whom had leak volumes < 110 mL) found that the test did not predict postextubation stridor (positive predictive value = 0).[10]

In this issue of RESPIRATORY CARE, Kriner et al add substantially to our understanding of the ability of the cuff-leak test to predict postextubation stridor.[11] These investigators performed a quantitative cuff-leak test on 462 prospectively identified patients who had been intubated for an average of 5 ± 4 days in medical and surgical intensive care units of a large, urban hospital. Leak volume was determined by measuring the difference in exhaled tidal volume before and after cuff deflation during positive-pressure ventilation, and a failed cuff-leak test was defined as a leak volume of ≤ 110 mL, or $\leq 15.5\%$ of exhaled volume before cuff deflation, using previously derived thresholds.[7,9] As in previous studies, patients with large cuff leaks were unlikely to develop clinically important postextubation stridor (10/380 patients); however, of 82 patients who had cuff leak ≤ 110 mL, only 10 developed stridor. The positive predictive value of a failed cuff-leak test was thus only 12%—a number that was not appreciably improved by the use of the percentage of exhaled volume to define a failed test (positive predictive value = 15%). More tellingly, only 2 of 7 patients who required reintubation had leak volumes ≤ 110 mL (positive predictive value for reintubation = 2%), and the difference in leak volume between those who did and did not require reintubation was not significantly different (181 ± 158 mL vs 131 ± 137 mL, $p = 0.47$, by my calculations). The authors also identified female gender, increased duration of intubation, and a larger ratio of endotracheal tube to laryngeal size as predictors of stridor.

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Kriner et al[11] conclude that the cuff-leak test is an unreliable indicator of postextubation stridor; I agree with them and would go so far as to recommend abandoning the use of this test as a routine screen prior to extubation of adults. In my institution a qualitative cuff-leak test is performed on all patients, and it has been my personal experience that a failed test may lead to unnecessary handwringing and prolonged intubation more often than not. In addition, although a large cuff leak may seem reassuring with those patients who have other risk factors for postextubation stridor and obstruction, the study by Kriner et

al suggests that the size of the leak does not reliably predict which patients will require reintubation for upper-airway obstruction, which is the end point of primary concern to clinicians.

How and when should the cuff-leak test be performed? The Kriner et al study[11] suggests that quantification of the cuff leak is no better than qualitatively identifying a leak by listening; they could not identify a threshold leak volume that predicted stridor. The issue of when to perform a cuff-leak test is more complex and will require further study. The reliability of a test is often better when its use is limited to high-risk populations, so identification of patients at risk for postextubation stridor and airway obstruction is key to defining the value of the cuff-leak test. As mentioned earlier, the cuff-leak test does appear to be more useful with children than with adults.[2,3] Duration of intubation also plays an important role in determining the risk of postextubation stridor. In the absence of other risk factors, patients who are intubated for less than 36 hours are extremely unlikely to develop clinically important postextubation airway obstruction, independent of the presence of a cuff leak; the leak test should be avoided with these patients.[1,10] On the other hand, Kriner et al found that important stridor occurred more than twice as often in patients who were intubated for more than 6 days than in those intubated less than 6 days (7.1% vs 3.3%).[11] Likewise, female patients are approximately 3 times as likely as male patients to develop important stridor.[1,11] Postextubation airway obstruction may also occur more frequently in patients with other risk factors, including recent airway trauma, surgery, or other risks for airway edema or obstruction.[4] Lastly, a failed cuff-leak test may be useful in increasing vigilance at the time of extubation of those patients known to be difficult to intubate, since the consequences of airway obstruction may be more severe. However, further studies that limit the use of the cuff-leak test to higher-risk populations are needed to determine whether the leak test is of any real general clinical utility or is just another roadblock that delays timely tracheal extubation.

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