Endotracheal Tube Size Is Associated With Mortality in Status Asthmaticus: A Confirmation of the Suspicion?

There are significant risks associated with intubation and mechanical ventilation in all populations,[1,2] more so in patients with certain conditions such as status asthmaticus.[3] With intubation, there is a transition from spontaneous breathing through the anatomic airway typically combined with mechanical breathing at supraphysiologic flow through a narrowed *artificial* airway causing an immediate substantial increase in airways resistance of the upper airway.[4] In the patient with asthma, this effect compounds the preexisting elevated airways resistance stemming from inherent airway inflammation, increased mucus accumulation, and bronchospasm.[5] Particularly challenging in this patient population is the current lack of standardization for the selection of a proper endotracheal tube (ETT) size prior to initiating invasive mechanical ventilation. Although studies have attempted to elucidate various ETT sizing recommendations and guidelines,[6,7] there remains no consensus for ETT selection in any adult population.

In this issue of Respiratory Care, Kashiouris et al[8] specifically evaluated the association between ETT size and mortality in subjects with status asthmaticus. They evaluated the most common adult ETT sizes used in current practice and concluded that the mortality rate was higher in subjects with status asthmaticus that were intubated with smaller ETTs. Specifically, in subjects intubated with ETT size ≤ 7.0 mm internal diameter (ID), in-hospital mortality was highest (31.3%), more than double the mortality in the ETT size ≤ 7.5 mm ID group, and 12% higher mortality than the ≥ 8.0 mm ID group. In summary, the group reported "taller subjects with the smallest ETT had the highest mortality."

In the study by Kashiouris et al,[8] for the ETT size groups, COPD was identified as the predominant comorbidity at admission (203/274, 74%); and as expected for status asthmaticus admissions, emergency medicine physicians were the most common intubating personnel (134/274; 48.9%). The highest Sequential Organ Failure Assessment score (SOFA) category for all ETT size groups, indicating highest risk for mortality, was the SOFA score for cardiovascular.[8] Overall, the study population was not dissimilar to many common patient encounters in a typical setting; and the data can, therefore, offer valuable insights for clinical practice.

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The current study of status asthmaticus subjects indicated higher overall mortality for intubated subjects than non-intubated with smaller ETT sizing further increasing rate of mortality.[8] For the clinician, intubation is often under emergency circumstances, and various size selections should remain available. Historically, studies have provided data that suggest proper ETT size selection should be based on a variety of factors such as sex and height due to individual tracheal size variation.[7,9] Whether an ideal ETT size exists, however, is an ongoing topic of debate. Height in particular has long been established as a strong predictor of tracheal size, and although there are clear benefits to selecting a larger ETT, many complications are associated with ETTs of larger diameter. Empirically, a larger ETT may be superior to a smaller selection, particularly in patients with preexisting elevated airways resistance. Although there are clear benefits to employing the largest possible ETT size in the care of a patient with status asthmaticus, intrinsic risks such as laryngotracheal mucosal damage[10] and tracheal stenosis[6] are associated with larger ETT size.

Studies evaluating an infant or pediatric model suggest that even with slight variations (decrease) in ETT size, airways resistance significantly increases with a variability in the resistance most associated with flow.[11,12] However, with the ubiquity of integrated automated mechanical ventilation systems to account for ETT-induced resistive forces, Branson posed the question almost 20 years ago whether tube-induced resistance should still be a concern.[13] A recent review by Demoule et al[5] emphasizes the need to purposefully avoid hyperinflation during mechanical ventilation in patients with severe asthma by employing a combination strategy of conservative tidal volume and breathing frequency with high flows to encourage adequate expiratory time; however, the application of high flows may be an individual risk factor for ventilator-induced lung injury.[14]

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Tube radius is by far the most impactful variable to influence flow throughout the respiratory system. Poiseuille's law applied to ventilation through an artificial airway dictates that under laminar flow conditions even a small decrease in the radius of a tube results in a significant decrease in gas flow at the same driving pressure. Extrapolating this concept, any entity such as secretions or biofilm that causes a decrease in artificial airway diameter should also be a concern.[15] Kashiouris et al[8] suggest that in-hospital mortality for status asthmaticus subjects was most associated with smaller ETTs. With current mechanical ventilation recommendations for patients with overall severe air flow obstruction that suggest application of high flows with conservative minute volume to reduce hyperinflation,[5,16] it would stand to reason that an ETT of larger size would be desirable.

It was once a universal recommendation to place the largest ETT possible during intubation,[17] and this principle may still be relevant in certain scenarios. However, current recommendations support a judicious approach to ETT sizing and selection. It has been offered that a predictive formula may better serve the process of adult ETT selection similar to the formulae used in neonatal and pediatric populations. Additional suggestions such as airway imaging assessment have also been proposed,[18] but under emergent intubation circumstances, these methodologies may not be feasible.

It seems logical that some form of algorithm should be developed for ideal adult ETT selection that incorporates a model that integrates similar elements as currently used for neonatal and pediatric ETT selection. Practically, with the limited range for what is considered a standard adult sized ETT, the clinician must simply decide between a selection that traditionally ranges from a 7.0 mm ID to the typical largest available, usually 9.0 mm ID. Keeping in mind that status asthmaticus is a complex presentation that requires an astute approach to ETT selection and mechanical ventilation implementation, perhaps mechanical ventilator settings expertly applied should be of greatest concern. In summary, there remains a delicate balance between the pursuit of establishing the largest ETT radius possible to avoid unnecessary airways resistance and the avoidance of tracheal damage from an oversized ETT. More research should be devoted to establishing a practical approach to safely and quicky appraising an ideal ETT size in the adult patient beyond the realm of empiric estimation.

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