Complications of Laryngeal Masks in Children

Big Data Comes to Pediatric Anesthesia

In this issue of Anesthesiology, Mathis et al. from the University of Michigan use “big data” to lend clarity to the obstacles encountered when using first-generation laryngeal mask airways (LMA) in children. Big data refers to the statistical and analytical use of many thousands of data points in a retrospective manner to determine subtle patterns and correlations that would otherwise not be detected in a prospective study with a smaller and less random sample. It is a compromise between knowing “why” and “how” in favor of “what” and “when.” It is the current way that large corporations predict consumer-buying patterns, flight delays, and it is how Billy Beane revolutionized major league baseball.

When Mathis et al. applied the principles of big data to children who had airway management with an LMA, they discovered previously unrecognized and novel risk factors that increased the risk of LMA failure. These included prolonged surgical duration, procedures of the head and neck, nonoutpatient admission status, congenital airway abnormalities, and a category the authors called “patient transport,” which consisted primarily of moving a patient’s position or anesthetizing location with the laryngeal mask in situ. Without the analysis of many thousands of patients, subtle differences in risk factors such as these could not have been detected. But, big data must be interpreted with caution, and in context, if it is to be clinically useful. Because the analysis consisted of many different types of patients, procedures, and practitioners, it provides an excellent basis with which to plan prospective trials with increased internal validity.

One of the factors shown to be associated with an increased risk of LMA failure was its use with head and neck procedures. One can surmise that an LMA is more likely to fail in cases where excess motion/rotation of the head or neck occurs or where the surgeon somehow comes in contact with the structures surrounding the LMA. However, with big data, we are only left to surmise, because retrospective correlations do not reveal causation. And, unless another analysis is performed—one that compares the complication rate between the LMA and the endotracheal tube for children undergoing head and neck procedures, our prediction that LMAs are more likely to fail in these procedures has lost its clinical significance, for this additional analysis may reveal that LMAs are safer than endotracheal tubes, even though they may fail more than in other types of procedures.

The risk factors of longer-duration surgeries and nonoutpatient procedures are puzzling. What is it about these risk factors that leads to a greater association with LMA failure? Does the larynx change shape over time because of differing levels of muscle tone or tissue tension during a long procedure? Are nonoutpatients somehow different? We will never know from studies that use big data methodology, but now we can plan future studies that randomize between LMA and endotracheal tube or different surgical lengths or different admission status to determine the causative relationships between these factors.

One of the more curious results in this study is the finding that LMA failure was more likely in children with acquired or congenital airway syndromes. It is this type of result that is one of the bugaboos of examining big data and requires careful examination. On one hand, this result is not surprising, because one can surmise (there we go, surmising again) that the LMA was designed with the normal pharyngeal anatomy in mind. It is reasonable to imagine that a pharynx with altered anatomy would predispose to a situation that causes air leakage around the LMA. On the other hand, qualitative descriptions reveal that laryngeal masks have been used for airway management in children with various airway anomalies, and it is possible that the LMA is not consistently effective in these situations.

“What is it about these risk factors that leads to a greater association with LMA failure?”

Accepted for publication September 13, 2013. The author is not supported by, nor maintains any financial interest in, any commercial activity that may be associated with the topic of this article.

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indispensable for the safe management of the pediatric difficult airway since their conception.\(^2\)\(^,\)\(^3\) Undoubtedly, the LMA has prevented countless numbers of hypoxic events in children who would not have otherwise been able to be intubated or ventilated. Although Mathis et al. report a higher risk of LMA failure in children with these types of deformities, one would never want to conclude that the LMA is too risky to use in this population. The more rational conclusion based on the results, as well as extensive experience and analysis of the published literature, is that the LMA can be a life-saving device in children with airway anomalies but may not be the best choice during maintenance of a general anesthetic in this particular patient population. These points emphasize that every child is a case-by-case risk–benefit ratio decision, and the data reported herein is another small piece of the large body of knowledge that influences this ratio.

A small, yet interesting aspect of the data set in this study is the use of neuromuscular blockers in patients with an LMA. Many anesthesiology residents are taught that LMAs should only be used with spontaneous, not-controlled, ventilation. After all, the LMA does not provide a tight seal around the larynx, and the use of positive pressure with an LMA in place may result in ineffective ventilation and gastric inflation. But, is this really correct? In healthy patients, especially young children who only require low-inflating lung pressures, I believe that controlled ventilation works well and may even be preferable in many cases because it prevents that pesky laryngospasm that sometimes occurs during sudden bursts of surgical stimulation, as when the surgical resident pulls on the spermatic cord during a herniorrhaphy. Can use of neuromuscular blockers prevent LMA failures? Because the number of patients who received neuromuscular blockers in Mathis’ dataset was so low, we cannot tell from the current study. But, big data should be able to tell us eventually.

Although analysis of big data is a powerful method to clarify significant and nonsignificant differences, one must keep in mind that small differences may not be clinically meaningful, and all patients, especially children, should be treated as individuals with a unique set of clinical needs. For example, even though the authors demonstrated that size 1.5 LMAs had a higher risk of failure, in some circumstances, an anesthesiologist may determine that it is the most appropriate airway management option. The authors didn’t find a similar increased risk in patients with a size 1 LMA but with only 27 infants managed with this size, the big data wasn’t big enough to tell us.

Since the beginning of the laryngeal mask era that began in the early 1990s, and revolutionized the practice of anesthesiology and patient safety, there have been many attempts to improve upon the original design. There are numerous second-generation LMA models (e.g., Proseal, Supreme, and many more) as well as slightly different types of devices that can all fit under the broad category of supra-glottic airway devices. As first-generation LMAs are gradually left behind in favor of newer devices, big data will once again be there to clarify subtle clinical differences between generations. Pediatric anesthesia has become so safe that this methodology will be the only way to sort out differences in clinical practice.

When we become comfortable using methods that analyze very large amounts of clinical information, randomized, controlled trials with relatively small numbers of patients will seem obsolete, unless one wishes to know more details about mechanism and causation.\(^4\) The external validity and relative “messiness” that big data provides will need to be carefully weighed against the internal validity of the prospective study, whose results may vary depending on the clinical circumstances of the study subjects. Big data may even spread into nonmedical areas to help us predict risk factors. As an example, it is only a matter of time before consumer and medical databases are cross-referenced to determine if parents’ shopping habits are associated with a higher risk of laryngospasm, and thus, should not be managed with an LMA.

In conclusion, Mathis et al.’s use of big data to determine factors associated with LMA failure in children is only the tip of the iceberg with regard to improving safety in pediatric anesthesia and other practices with relatively low error rates. The information gleaned from big data analyses will help us plan clinically relevant prospective studies, and when the numbers are large enough, may even help us plan the safest anesthetic.

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References