Implications for Subspecialty Care of Anesthetized Children

Given the physiologic changes that occur during the 1st yr of life, the infant is in many ways a distinct species. Respiratory control is immature in the infant: the slope of the carbon dioxide response curve is less than in the older child or adult, and hypoxia may induce apnea rather than hyperventilation. Cardiovascular responses also are immature: the myocardium is poorly compliant, and hence cardiac output is rate-dependent. Sympathetic innervation is sparse, and vagal influences predominate. The list goes on.

Similarly, responses to anesthetic agents are different in the infant. Minimum alveolar concentration is less in the infant compared with that in the older child and is even less in the preterm. The uptake of volatile agents is more rapid because of an alveolar ventilation that is large relative to functional residual capacity, a high cardiac output, and low blood–gas partition coefficient. Volatile agents may cause more depression of cardiac output in infants than in older children or adults and have a more profound effect on baroreflexes. Clearance of fentanyl and other opioids is less rapid and more variable in the infant. This list also goes on.

Given the differences between infants and adults, it should not surprise us that infants fare less well during anesthesia than older children or adults. Excessive anesthetic morbidity and mortality in children was reported 40 yr ago. It has been more than 30 yr since Rackow and colleagues suggested that any difference between adults and children in the rate of cardiac arrest during anesthesia was due to an increased frequency of such events in children less than 1 yr of age, and other studies have supported that conclusion. In 1988, large series both in Sweden and in France showed an increased risk of cardiac arrest in anesthetized children less than 1 yr of age compared to that in older children and adults. By including children less than 1 month of age as a separate category, a Canadian study found the greatest rate of adverse events intraoperatively and in the recovery room in this youngest age group.

In this issue of Anesthesiology, Keenan and colleagues, of the Medical College of Virginia, present data that, if correct, are consistent with the theme of increased anesthetic risk for children less than 1 yr of age. Using a computerized database, they reviewed the incidence of bradycardia over an 8-yr period in anesthetized children from birth to 4 yr of age. Bradycardia was most frequent in infants less than 1 yr of age and was associated with significant morbidity, including hypotension in 30%, asystole or ventricular fibrillation in 10%, and death in 8%. Associated factors included ASA physical status 3–5, prolonged surgery, emergency surgery, and care by an anesthesiologist not trained or experienced in pediatric anesthesia. Keenan and colleagues conclude by asking whether the routine use of pediatric anesthesiologists might decrease the excessive anesthetic morbidity and mortality in infants.

Is a move toward subspecialty care of infants warranted by the data? As the authors point out, the study was retrospective, attended by all of the problems that are part of such a study design. Case assignment was not random; the assignment scheme could have placed a disproportionate number of infants into the care of pediatric anesthesiologists, particularly in the last few years of the study. On the other hand, after-hours emergency care of very sick infants could have fallen disproportionately to nonpediatric anesthesiologists, because they probably outnumbered their pediatric colleagues in the call system.

The authors also recognize the potential for bias in a study that depended on self-reporting from the primary anesthesiologist as to whether or not a “clinically significant” bradycardia had occurred. Such a subjective assessment of the importance of a decrease in heart rate determined the total number of cases available for further analysis and thus could have influenced the frequency distribution.

Does bradycardia represent an adverse event and thus warrant measurement of its incidence as an index of outcome and of clinical competence? Most bradycardia is easily treated and without consequence. When car-
Diastolic arrest does occur during anesthesia, however, it frequently is preceded by bradycardia. Most pediatric anesthesiologists recognize bradycardia as a sign of hypoxia, hypotension, or anesthetic overdose, and if undetected or ignored, as a harbinger of cardiac arrest. Therefore, the incidence of bradycardia represents only a first approximation of clinical competence. Failure to recognize the presence and cause of bradycardia and failure to reverse the trend in heart rate would be better measurements.

Although the authors defined "cause of bradycardia" as carefully as is possible in a retrospective study, assignment of cause in any given case was not unambiguous. Assignment of a patient to the "anesthetic dose" category was made if bradycardia occurred within 30 min of an increase in concentration and in the absence of hypoxemia. The mean inspired halothane concentration of 1.7 ± 1.1% (SD) at the time of bradycardia means that some of the patients were receiving less than 1 MAC. Eleven of 21 of this group also were ASA physical status 3–5; perhaps many of these could have been listed in the "disease" or "surgery" category. The ambiguity in assigning cause is well illustrated by these authors' assignment in a previous study of four patients who died in the anesthetic dose category, whereas in the current study, presumably the same patients were assigned to the disease or surgery category. This ambiguity in assignment of cause of bradycardia is relevant because it is only in the anesthetic dose category that patients under the care of pediatric anesthesiologists had a lower incidence of bradycardia than those cared for by nonpediatric anesthesiologists. This reduces the case for subspecialty care of infants to the authors' generalization that pediatric anesthesiologists may be "more familiar with the depressant effects of volatile agents (notably halothane) on the heart of infants than are their colleagues."

Regardless of these limitations, both pediatric and nonpediatric anesthesiologists are likely to find the study by Keenan et al. interesting and provocative. Its conclusions, while certain to be controversial, are consistent with those from other studies that have suggested that anesthetic risk is increased in infants compared to older children or adults. It goes beyond these previous studies, however, because it suggests that subspecialty anesthesiologists can improve patient outcome. In other specialties, improved outcome for a variety of high-risk procedures (e.g., congenital heart disease surgery, coronary artery surgery, and coronary angioplasty) has been positively associated with case load. Similarly, delivery of intraoperative care of infants by anesthesiologists with the necessary pediatric training or experience could improve outcome, although this will be difficult to prove, given the low frequency of adverse events.

What defines "competency" in pediatric anesthesia? Although fellowship training programs in pediatric anesthesiology have existed for more than 20 yr, neither a certification process, nor even any consensus on criteria for competency, exists. Currently, directors of training programs in pediatric anesthesiology across North America are attempting to define competency in the care of children for general and subspecialty anesthesiologists. As implied by the makeup of the pediatric anesthesia group at the Medical College of Virginia, competency in pediatric anesthesia could and eventually will be defined either by training (i.e., fellowship) or by experience (i.e., case mix and load).

Do we really have a choice? Performance-based credentialing already has been introduced as a requirement for hospital anesthesiology privileges by state and national medical licensing bodies. A recent study in northern California suggested that in 85% of the region's hospitals, at best, one anesthesiologist would meet performance-based credentialing criteria of caring for at least one infant younger than 6 months of age per week. The majority of these institutions were within 50 miles of hospitals providing care for a larger number of infants per week.

Cost will become an increasingly important factor. Because care for infants requires specialized equipment and facilities, the hospital in which a small number of infants are cared for may find it cannot recoup its costs. Hospital administrators may see benefit in consolidating services for infants locally or in transferring them to regional centers.

Failure to do one or the other may expose both the hospital and anesthesiologist to significant medicolegal risk. Even now, before implementation of performance-based credentialing, the anesthesiologist who cares for infants should recognize that closed malpractice claims involving infants less than 6 months of age represent the single largest group, accounting for 20% of all pediatric claims.

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EDITORIAL VIEWS

Certification, credentialing, cost, and medicolegal exposure: each is part of the changing profile of medical care in this country, and each is directing us toward subspecialization. The most compelling reason to move in the direction of subspecialization, however, would be improvement in patient outcome. Keenan and colleagues tantalize us with this possibility.

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