FAER Foundation for Anesthesia Education and Research

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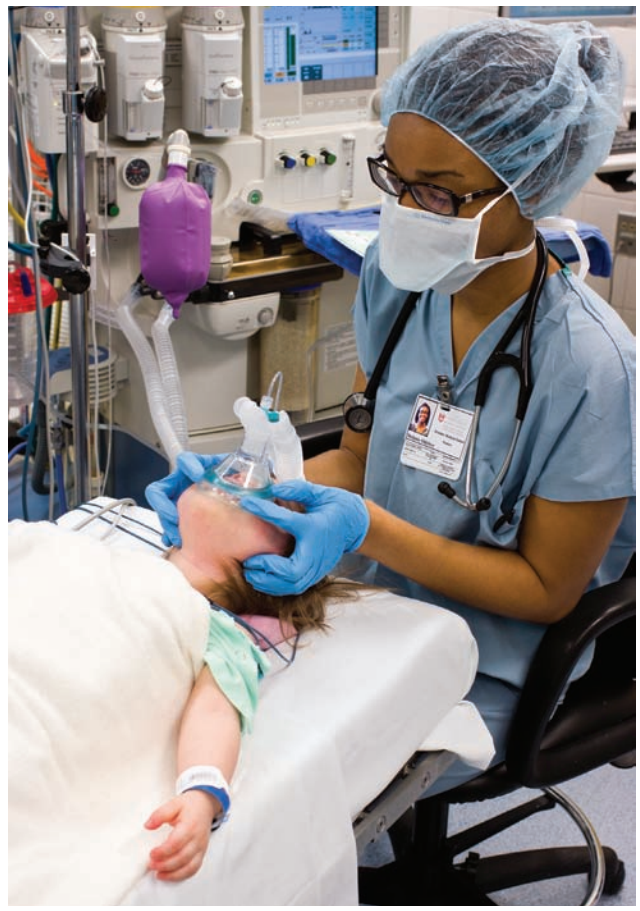
Optimizing Children's Outcomes After Anesthesia and Surgery

Yu Shi, MD, MPH

Anesthesia can be an essential part of health care for children, with approximately 15% of children receiving at least one anesthetic before their third birthday (*Paediatr Anaesth* 2018;28:513-9). As anesthesiologists, we make every effort to provide comfort and safety to those children and their families. However, there are concerns that children's encounters with anesthesia may not only cause short-term stress for them and their families but in some cases may also have potential longer-term impact on their behavior. My overall research goal is to understand how anesthesia and procedures such as surgery impact children and their families so they can have the very best outcomes.

Research suggests that many children experience short-term behavioral changes after surgery and anesthesia, with some parents reporting anxiety as well as changes in eating and sleeping behaviors that could last for weeks (*Pediatrics* 2006;118:651-8). Dr. Zeev Kain was a pioneer in studying the factors leading to these behavioral changes and promoting interventions to improve the experience of children and their families. Perioperative anxiety and stress experienced by children and their parents are associated with more marked behavioral changes. Interventions such as preoperative education for children and parents, premedication, and parental presence during induction have been widely adopted into our daily practice. For example, many of us enjoy playing and singing with children when we provide anesthesia care, and we hope that such interactions with kids will help ease their way through the perioperative period.



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More recently, strong evidence from animal studies that anesthetic agents cause injuries to the developing brain raised concerns that exposure to anesthetics might also have long-term impact on behavior and cognition in children (*Anesthesiology* 2018;128:832-9). However, findings from human studies have been less conclusive. Three recent well-designed studies (GAS, MASK, and PANDA) have not found any changes in cognition of children after exposure of anesthesia at a young age, including general intelligence, memory, and many other domains (*Anesthesiology* 2020;132:1587-8). A possible explanation to the apparent discrepancy between animal and human studies is that the development of children is much more complex than that of laboratory animals. Child development is influenced by family environment, education, and many other factors that may be more important than any neurotoxic effect of anesthetics. However, a recent meta-analysis of the results of these three studies found that even a single exposure to anesthesia prior to age 3 was associated with more parent-reported behavioral difficulties (*Br J Anaesth* November 2020). Thus, despite the fact that most children will do "just fine," some of them might be more vulnerable to the long-term consequences of anesthesia. As another example, a series of studies in Olmsted County, Minnesota, consistently found that multiple exposures to anesthesia prior to age 3 is associated with a higher risk of ADHD (*Anesthesiology* 2017;127:227-40). In other studies of children with cancer, who usually require many episodes of anesthesia, the cumulative duration of anesthesia predicts worse neurocognitive outcomes (*J Pediatr* 2020;223:141-7).

As a researcher, I am curious about the determinants of the short- and long-term impacts of anesthesia and surgery on children and families. For example, I wonder if short-term postoperative behavioral changes are linked to any long-term behavioral changes. Given the multiple potential influences of environmental factors on child development, I have developed a conceptual framework to guide future studies of how procedures requiring anesthesia affect outcomes, building on existing models of pediatric medical trauma stress (*Anesthesiology* 2018;128:700-3). In this framework, a child's baseline characteristics and procedural factors contribute to a child's acute responses to the general anesthesia encounter. The acute responses may lead to early, evolving changes in affect, behavior, or cognition. Changes in the early postoperative period may resolve or evolve into longer-term consequences for child development. Contextual factors, including family functioning, may moderate both a child's acute response to anesthesia and the evolution of short- and longer-term outcomes. In turn, the anesthesia encounter itself may also modify these contextual factors, which can further influence subsequent outcomes.

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I was awarded a Mentored Research Training Grant by the Foundation for Anesthesia Education and Research (FAER) to develop my research in this area. Mentored by Dr. David O. Warner, I am currently conducting a study titled "Longitudinal assessment of affect, behavior, and cognition in children undergoing general anesthesia," which evaluates the trajectory of behavior, cognition, and family functioning in preschool children (aged 2.5 to 6 years) undergoing elective surgery. The FAER grant allowed me to obtain preliminary data on the utility of my conceptual framework and to develop skills in neurodevelopment assessment, community engagement, and qualitative methods. Building on the knowledge I learned from the training experience during my FAER grant, I am also exploring the opportunity to apply evidence-based interventions to improve cognitive outcomes of children as well as parenting skills in children who require frequent anesthesia care, such as those receiving treatment for cancer. Even if anesthesia itself does not affect neurodevelopment, there are still multiple opportunities for anesthesiologists to optimize the outcomes of children's surgical experiences.

Parents trust us to keep their children safe and comfortable during a very stressful time for their family. Research efforts from our specialty have resulted in a better understanding of how anesthesia impacts children and improved clinical care for these young patients. I hope to contribute to the science and clinical practice in this exciting field and am grateful for the opportunity that FAER has given me to pursue this area. ■