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PREOPERATIVE EVALUATION (BJ SWEITZER, SECTION EDITOR)

Preoperative Considerations for Pediatric Patients: What Keeps Parents Up at Night?

Lynne R. Ferrari[1]

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Abstract

Purpose of Review Parents are often as concerned about the risks of general anesthesia in their children as they are about the surgical or interventional procedure itself. Parents search the internet and rely on media for information regarding anesthesia and are often confused by conflicting or erroneous information.

Recent Findings Recent attention has been given to both the potential neurotoxic effects of general anesthesia in young children and increased understanding of the long-term consequences of concussion. The focus on health care spending has directed more surgical procedures to be performed on an outpatient basis. The guidelines for outpatient tonsillectomy which is one of the most frequently performed surgical procedures in the pediatric population are often unclear. Finally, as the number of immunizations required for children is increasing the likelihood of immunization prior to general anesthesia is increased. Is it safe to proceed?

Summary These are some of the concerns that contemporary parents have which the anesthesiologist must be prepared to address.

Keywords Neurotoxicity · Concussion · Obstructive sleep apnea syndrome · Sleep disordered breathing · Tonsillectomy · Immunization

Introduction

With easy access to the internet, patients and families have more information than ever before regarding medical care. In addition, specific medical issues describing the care of infants and children have been highlighted in the media and have the potential to confuse parents when faced with anesthesia and surgery in their children. Many anesthesiologists find themselves in the position of having to answer complicated questions regarding the safety of anesthesia, timing of surgery, and appropriateness of post-procedure disposition.

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✉ Lynne R. Ferrari
lynne.ferrari@childrens.harvard.edu

[1] Department of Anesthesiology, Perioperative and Pain Medicine, Boston Children's Hospital, 300 Longwood Avenue, Bader 3, Boston, MA 02115, USA

Risk

Parents and providers alike are interested in a measure of perioperative risk when planning general anesthesia and surgery in infants and children. As pediatric anesthesia has become safer over the years, the risk of adverse events in children undergoing general anesthesia for routine surgery is relatively low [1]. Risk factors associated with serious adverse events in pediatric patients include ages less than 12 months, coexisting disease, American Society of Anesthesiologists Physical Status (ASA-PS) > III, and emergency surgery [2]. Children with congenital heart disease either repaired or unrepaired have a higher incidence of anesthesia-related cardiac arrests [3, 4]. The most frequent cardiovascular causes of cardiac arrest in these children are hypovolemia from blood loss and hyperkalemia from transfusion of stored blood whereas airway obstruction from laryngospasm is the most common respiratory etiology of cardiac arrest [4, 5]. Although the most widely applied assessment of risk is the ASA-PS assessment, this score was initially designed for adult patients and was never intended as a tool to predict pediatric perioperative risk [6].

There have been several studies to more specifically assess risk in pediatric patients undergoing general anesthesia. The pediatric-specific NARCO-SS (Neurological, Airway, Respiratory, Cardiovascular, Other categories and Surgical Severity) score has been validated in one US center as a tool to predict perioperative adverse events [7]. The Pediatric Risk Assessment score (PRAm) was developed to predict perioperative mortality in children undergoing non-cardiac surgery. Using this tool, patients are assigned a risk score based on objective assessment of comorbidities. The findings that predict an increase in perioperative risk include urgent surgical procedures, the presence of respiratory disease, congenital heart disease, acute or chronic kidney disease, neurologic disease, hematologic disease, mechanical ventilation inotropic support, and the presence of neoplasm with or without preoperative chemotherapy [8]. The best assessment will have to include information from multiple resources.

Neurotoxicity

Recent allegations that commonly used anesthetic drugs are deleterious to the developing brain have caused concerns among medical professionals and the lay public. The U.S. Food and Drug Administration (FDA) has published a warning that repeated or lengthy use of general anesthetic drugs in children younger than 3 years may affect the development of the child's brain. This warning appears to have been issued to raise awareness among practitioners and the public to ensure the information needed to make informed judgments about the risks and benefits of anesthesia and sedation in young children [9••]. The warning continues to state that recent human studies suggest that a single, relatively short exposure to general anesthetic and sedation drugs in infants or toddlers is unlikely to have negative effects on behavior or learning [10]. Animal studies have demonstrated that commonly used anesthetic, sedative, and analgesic agents are associated with neuroapoptosis and neurobehavioral deficits; however, the mechanisms underlying the neurotoxic effects have not been elucidated. Most general anesthetics can affect brain development in all animal models [11•]. The duration and dose of anesthetic agents used in animal studies are significantly greater than those used in otherwise healthy pediatric patients undergoing brief, elective surgical procedures; therefore, these results cannot reliably be applied to humans [12–15]. The two largest studies examining the effects of general anesthesia on infants and children are the PANDA (Pediatric Anesthesia and Neurodevelopmental Assessment) and GAS (General Anesthesia vs. Spinal Anesthesia) studies and neither found evidence of adverse neurodevelopmental outcomes [16, 17].

The FDA statement also includes "Health care professionals should balance the benefits of appropriate anesthesia in young children against the potential risks, especially for procedures that may last longer than 3 hours or if multiple procedures are required in children under 3 years. Discuss with parents and caregivers, the benefits, risks, and appropriate timing of surgery or procedures requiring anesthetic and sedation drugs" [18]. Most of the epidemiological studies are retrospective and include significant confounders of underlying pathology and surgery [16]. Studies in children have limitations that prevent experts from understanding whether the harmful effects were due to the anesthetic drugs or to other factors such as the surgery or related illness [19]. In addition, there are few procedures in children that are purely elective and can be safely postponed until after 3 years of age [13, 20].

Sleep-Disordered Breathing and Obstructive Sleep Apnea Syndrome

Children with obstructive sleep apnea (OSA) and sleep-disordered breathing (SDB) present specific challenges that should be addressed in an effort to minimize the risk of perioperative morbidity or mortality [21]. The preoperative evaluation of these patients includes a thorough medical record review, patient and family interview, review of screening evaluations, and physical examination. Definitive diagnosis may be made by the use of polysomnography (PSG), commonly referred to as a "sleep study" [22]. Although this diagnostic modality is highly reliable, it is inconvenient, expensive, and not widely available. Additional concerns regarding testing include lack of consensus on what constitutes an abnormal study, poor access to a qualified sleep center, and specialist to obtain and to interpret the results. Consequently, less than 10% of children undergo PSG prior to tonsillectomy [23]. In the absence of formal polysomnography, many children with symptoms of SDB go unrecognized and thus may be at risk for perioperative respiratory adverse events [24, 25]. The STOP-BANG questionnaire is very predictive in the adult population but is not applicable to pediatric practice [26–28]. Efforts have been made to create an equivalent simple screening tool for children with sleep-disordered breathing; however, the risk assessment for perioperative complications is still not ideal. The sleep history is important and should include the sleep environment as well as characteristics of the sleeping pattern. If a positive history of snoring is elicited, a more detailed history should be sought. Snoring should be quantified for frequency and loudness. Parents should be queried for the presence of labored breathing during sleep, restless sleep, apnea, diaphoresis, enuresis, nightmares, cyanosis, daytime somnolence, learning disorders, poor academic performance, and attention deficit hyperactivity disorder. Loud snoring does not necessarily correlate with the degree of obstruction, and noticeable snoring may occur without apnea. Parents report loud snoring, mouth breathing, or long pauses in children who have normal PSG studies. Children

with OSA usually have obstruction during REM sleep in the very early hours of the morning when parents may not be observing them. Therefore, there is the potential for underestimating obstructive events. History and physical examination alone are poor predictors of OSA in pediatric patients. Abbreviated screening such as videotaping, nocturnal pulse oximetry, and daytime nasal PSG tend to be helpful if results are positive but have a poor predictive value if results are negative. A 22-item Sleep-Related Breathing Disorder (SRBD) scale used to predict obstructive sleep apnea syndrome showed a sensitivity of 81% and a specificity of 87% in children aged 2–18 years [29]. The use of clinical history combined with anthropometric measurements of neck circumference and body mass index to identify OSA without the need for polysomnography correlates well with findings on sleep studies, suggesting that development of a preoperative screening tool based on clinical history may be feasible. A six-item scale has been identified using multivariable analysis, demonstrating good predictive value for moderate and severe OSA [30]. Other screening questionnaires for pediatric patients with OSA include the Pediatric Sleep Questionnaire Sleep-Related Breathing Disorder (SRBD) and the STBUR (Snoring, Trouble breathing, Un-Refreshed) tool [25, 31]. Most of the current screening tools include questions regarding the presence of snoring or brief apnea during sleep, feeling unrefreshed or tired on awakening after sleep, the presence of nocturnal bed wetting, cessation of normal growth patterns, and obesity [24, 32, 33]. Currently, no clear risk stratification or identification tool exists to properly plan for the disposition of pediatric surgical patients with unknown severity or diagnosis of OSA/SDB [30].

T&A Outpatient Criteria

The indications for tonsillectomy, with or without adenoidectomy, have changed in recent years. Over 500,000 tonsillectomies are performed in the USA every year with the vast majority of these performed safely in an ambulatory setting. Advantages of efficiency, cost containment, and better resource utilization in the ambulatory setting for appropriate procedures suggest that this trend will continue. Potential complications that may be avoided by overnight admission are dehydration, uncontrolled nausea and vomiting, and inadequate pain control. However, one very large study of ambulatory otolaryngologic procedures determined the risk of complications to be 1% [34–36]. The prior focus on hemorrhage as the primary complication to be considered in children scheduled for outpatient surgery has shifted towards airway complications which have been hypothesized to pose a potentiality greater risk. More children are operated on for sleep-disordered breathing and obstructive sleep apnea and fewer for the previous primary indication of recurrent pharyngitis [37]. Guidelines from the American Academy of Otolaryngology Head and Neck Surgery recommend that candidates for outpatient tonsillectomy be healthy, greater than 3 years of age, ASA classification I/II, without significant obstructive sleep apnea-hypopnea syndrome, live in reasonable proximity to a major medical center, and are undergoing tonsillectomy for an indication other than peritonsillar abscess [38–40].

The determination of suitability of a child for outpatient tonsillectomy requires individual risk assessment [41]. Surgery performed in an outpatient setting may be safe provided patients are properly selected and a low threshold for readmission exists. Children under age 4 years have an unplanned admission rate of approximately 8% [39]. Age under 2 years, ASA 3 and 4 patients, surgical duration greater than 1 h, completion of surgery after 3 p.m., and the presence of obstructive sleep apnea are factors that increase the risk of unplanned postoperative admission [42•]. Therefore, admission to an inpatient facility is recommended in children who are under 4 years of age. Additional admission criteria include weight less than 16 kg, polysomnography-confirmed obstructive sleep apnea with an apnea hypopnea index > 3, severe obesity (BMI > 95th percentile for age), craniofacial anomaly, or known bleeding disorder. Children with concurrent neurological or neuromuscular disorder predisposing to upper airway obstruction, down syndrome, pulmonary disease (e.g., persistent asthma, recurrent pneumonia, bronchopulmonary dysplasia), cardiac disease requiring electrocardiogram monitoring, or airway anomaly (e.g., dwarfism, craniofacial anomalies) predisposing to airway obstruction or respiratory compromise are also not candidates for ambulatory tonsillectomy.

Children with obstructive sleep apnea, either obstructive or central in etiology, may exhibit continued respiratory compromise postoperatively and are not good candidates for outpatient tonsillectomy. In a recent study of children who had undergone tonsillectomy following polysomnography, specific selection criteria determined the safety of ambulatory surgery. Children with an apnea-hypopnea index between 1 and 15 were identified as having mild to moderate OSA and were included in the study. Children under 3 years of age, those weighing less than 10 kg, or those with significant coexisting disease were excluded. Children who had mild to moderate OSA and no other comorbidities had a low risk of postoperative complications following ambulatory surgery when observed for 6 h [43].

Although many children undergo tonsillectomy as an ambulatory procedure, there are indications that require admission postoperatively to an inpatient facility. Perioperative morbidity is related not only to the surgical procedure itself but the comorbid conditions associated with the indication for tonsillectomy. Factors to be considered when planning an outpatient procedure are the degree of OSA/SDB, anatomical abnormalities of the airway, status of coexisting disease, type of

anesthesia considered, elimination of opioid analgesics, patient age, adequacy of post-discharge observation, reliability of family, and access to medical facility post-discharge.

The postoperative observation period may vary between 2 and 6 h and often is surgeon specific. Similarly standard discharge criteria have not been defined; however, adequate administration of intravenous fluid and adequate analgesia should be established prior to discharge home.

Concussion

Concussion is a form of brain injury caused by either a direct blow to the head or an indirect injury with force transmitted to the head via impact to another part of the body. It results in a disturbance of brain function with physical, cognitive, and emotional sequelae, rather than gross structural injury [44••]. Sport- or recreation-related concussion may occur in the setting of trauma requiring surgical intervention under general anesthesia especially in adolescents. The effect of surgery and general anesthesia on brain recovery, either favorable or unfavorable, in this population is unknown. There is no evidenced-based, clinical pathway describing the optimal timing of surgery and anesthesia for semi-elective surgical procedures following a concussion. Elective surgery is often delayed in patients with known concussion until the patient is cleared to "return to play" or "free of symptoms." Rest and avoidance of second or recurrent collisions are essential to the patient's recovery. However, there is no clear clinical definition of "rest" or how much time is needed for full recovery [45]. The decision to proceed with surgery in patients with known concussion is based on individual clinician's judgment. In all clinical situations where traumatic brain injury (TBI) is a consideration, attention to physiological parameters such as blood pressure, glucose control, and ventilation during general anesthesia is essential. The literature suggests that second insults such as hypotension and hypocarbia cause cerebral ischemia and may worsen outcomes in adults and children after TBI [46–48]. Unfortunately, these secondary insults may occur during surgery and anesthesia and may cause further damage to an already injured brain which has the potential to delay recovery from concussion. The current recommendation is that, when feasible, elective surgery and anesthesia be deferred until physical restrictions are lifted. However, there is no evidence to support postponing urgent or emergent procedures.

Immunizations

The goal of vaccination is to stimulate the immune system and enable the production of antibodies against specific pathogens, which saves millions of lives every year. The vaccination schedule is made to maximize the efficiency of the immune system and should be adhered to as much as possible. Therefore, delayed immunization before and after surgery or anesthesia should be minimized. The effect of anesthesia on the immune response during elective surgery is minor and usually persists for 48 h and there is no contraindication to the immunization of healthy children scheduled for elective surgery. However, a delay prior to anesthesia of 2 days for inactivated vaccines such as diphtheria-pertussis-tetanus (DPT) or 14–21 days for live attenuated vaccines such as measles-mumps-rubella (MMR) immunization may be prudent [49, 50]. It is not uncommon for children to present for general anesthesia shortly after a scheduled immunization has been administered. When this occurs, procedures should not be automatically canceled but left to the discretion of the anesthesiologist and/or surgeon based on individual patient considerations. The time interval between immunizations and procedures may be important in preventing misinterpretation of vaccine-driven adverse events as postoperative/post-procedure complications. Post immunization effects include fever, pain at the injection site, malaise, and irritability. These clinical symptoms must not be confused with perioperative complications. This includes, but is not limited to, routine scheduled vaccines as well as seasonal and flu vaccine. When a vaccine is administered within 7 days of a scheduled procedure or in the case of unplanned procedures, both the anesthesiologist and surgeon should be informed.

Conclusion

As anesthesiologists expand their scope to the perioperative management of patients throughout the surgical episode of care, there will be more focus on preparing patients earlier and greater participation in surgical planning. It is incumbent on clinicians who regularly care for infants and children to be able to allay the fears of parents, dispel the myths surrounding risks of general anesthesia, and collaborate with surgical colleagues on timing and venue for surgery and anesthesia in their patients.

Compliance with Ethical Standards

Conflict of Interest Lynne R. Ferrari declares that she has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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