Preanesthetic Preparation of the Pediatric Patient

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Preoperative Laboratory Testing
Preoperative Fasting
Children with a Potentially “Full Stomach”
Preoperative History
Preoperative Physical Exam
Psychological Preparation of the Child
Psychological Preparation of the Parents
Allaying Parental Anxiety
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Pharmacologic Preparation of the Child
Midazolam
   Oral Midazolam
   Nasal Midazolam
   Intravenous Midazolam
   Rectal Midazolam
Diazepam
Clonidine
Ketamine
Methohexital
Fentanyl Orulet
Anticholinergics

Prior to the day of surgery, preanesthetic preparation of pediatric patients involves the appropriate choice of laboratory tests that will influence anesthetic management, the assignment of a preoperative fasting interval, and a focused history and physical exam that may influence anesthetic management (although this may occur on the day of surgery). On the day of surgery, the history and physical exam are updated, and the anesthesiologist then must focus on alleviating stress and anxiety of the patient and family (Box 12-1).

PREOPERATIVE LABORATORY TESTING

Hemoglobin determination is probably the most commonly performed preoperative blood test in children. Each center varies with regard to its requirement for preoperative hemoglobin testing in healthy children. Some children’s hospitals mandate routine preoperative hemoglobin testing in selected infants under 12 months. Furthermore, each has policies concerning the minimum hemoglobin level for performance of elective surgery on small infants. For example, at The Children’s Hospital of Philadelphia, infants below the arbitrary age of 6 months require a hemoglobin level above 10 g/dL to proceed with elective surgery. Unfortunately, there are little or no data to guide current recommendations for obtaining preoperative hemoglobin values in this age range. Healthy children over the age of 12 months do not require preoperative hemoglobin testing. Additional blood tests, radiographs, and urinalysis are not obtained in healthy pediatric patients prior to most surgical procedures. These studies are determined solely by the medical condition of the patient and the nature of the surgical procedure.

Collection of a preoperative type-and-screen or type-and-crossmatch to prepare for a potential blood transfusion will depend on the nature of the surgery and the expected blood loss. In general, if a blood sample is sent to the blood bank because of a possible anticipated transfusion, a hemoglobin value should also be obtained. Coagulation studies are not routinely performed except when there is a history of a potential bleeding disorder in the child or among his or her first-degree relatives. Many otolaryngology surgeons, however, will require these tests prior to elective tonsillectomy.

PREOPERATIVE FASTING

Multiple studies in the pediatric physiology literature have demonstrated that clear liquids are rapidly emptied from the stomach, regardless of chronological or gestational age. Children of all age groups who ingest clear fluids 2 hours prior to induction of anesthesia have a similar
gastric volume and pH as those fasted for longer periods. Shorter fasting intervals have not been studied. Practically speaking, there would be no obvious advantage to allowing ingestion of clear liquids less than 2 hours prior to surgery. Maintaining a 2-hour interval will allow for flexibility in OR scheduling if a case is canceled and if a child needs to be advanced to an earlier time slot in the schedule. There is no known association between the volume and pH of gastric contents and the risk of pulmonary aspiration.

Clear liquids generally consist of any fluid that can easily be seen through. Exceptions include cola soda and black coffee, which are allowable. The presence of fat or particulate matter such as pulp from orange juice will delay gastric emptying. Opinion is mixed on whether or not gelatin (Jell-O) should be considered a clear liquid. Most anesthesiologists have witnessed the clump of gelatinized substance that is present in the vomitus of children who recently ingested Jell-O, and therefore do not include it among the substances that qualify as a clear liquid.

Not only should children be allowed to drink clear liquids 2 hours before induction of anesthesia, they should be actively encouraged to do so. Parents should awaken their small child before an early morning arrival and encourage the ingestion of clear liquids. Advantages to this practice include an increased gastric pH, decreased risk of hypovolemia and hypoglycemia at the time of induction of anesthesia, decreased irritability of the child, and increased parental satisfaction. It has been demonstrated that prolonged preoperative fasting is associated with a greater decrease in blood pressure in infants during halothane administration.

There is no consensus as to the maximal amount of clear liquids that can be ingested. Some studies have used a certain amount by weight, some have limited the amount to 8 ounces, and others have allowed unlimited amounts. Nevertheless, the amount of clear fluids ingested 2 hours prior to surgery does not seem to influence subsequent gastric volumes. Therefore, an unlimited amount should be allowed within the prescribed time frame.

Breast-fed infants can be allowed to nurse up until 3–4 hours prior to surgery. Breast milk contains a large amount of fat, and empties slower from the stomach than clear liquids. However, there is some evidence that breast milk has a faster gastric emptying time than some

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**Box 12-1 The Eleven P’s**

The approach to the preoperative assessment of children should be structured with regard to specific tasks that include reviewing the anesthetic considerations for the child’s medical condition and surgical procedure, and developing a perioperative plan. A convenient and comprehensive method to remember this structure is to use a system I call the Eleven P’s. These are divided into preoperative, intraoperative, and postoperative considerations. Preoperative considerations are described in this chapter and include assessment of the patient, and decisions concerning premedication, preoperative fasting, and preoperative laboratory tests. In addition, the preoperative period is the time when intraoperative and postoperative concerns are contemplated, and management plans devised.

- **Patient:** An assessment of the patient includes the history, physical exam, obtaining the old chart to review previous anesthetics, and research into the anesthetic implications of any coexisting medical conditions.
- **Procedure:** The anesthesiologist must be familiar with the general aspects of the surgical procedure and the way in which these will affect anesthetic management.
- **Premedication:** Optimal choice of premedication is ordered.
- **Preoperative fasting:** Fasting orders are written. Parents of healthy children are encouraged to offer their child unlimited clear liquids 2 hours prior to the scheduled surgical time.
- **Preoperative labs:** Appropriate tests are chosen depending on the medical condition of the patient and the nature of the surgery.
- **Perioperative monitoring:** Additional monitors are obtained if dictated by the medical condition of the patient or the nature of the surgery.
- **Perioperative fluids:** Appropriate IV fluids are chosen depending on the age and medical condition of the child, and nature of the surgery.
- **Positioning:** Preparations are made to enhance patient safety when using a position other than supine.
- **Plan:** An anesthetic plan for induction, maintenance, and emergence from general anesthesia is formulated based on a combination of the above factors.
- **Pain:** Plans are formulated for intraoperative and postoperative analgesic requirements. This often includes a regional anesthesia technique.
- **Postoperative:** Considerations are given for possible postoperative concerns and complications depending on the medical condition of the patient and the nature of the surgery. Plans are made for possible ICU admission and ventilatory management if necessary.
infant formulas. Furthermore, many breast-fed infants will not be able to drink other types of liquids from a bottle. Since pulmonary aspiration is extremely rare in healthy infants, the advantages of allowing a relatively short fasting interval for breast milk probably outweigh the disadvantages.

Infant formula is completely emptied from the stomach within 4 hours in most children. When compared to infants allowed clear liquids up to 2 hours before surgery, infants who ingest formula 4 hours prior to surgery have similar values for gastric volume and pH. Therefore, infants should be allowed to ingest formula up to 4 hours prior to surgery.

Gastric emptying of solids is more difficult to study in pediatric patients. Most institutions allow solids until 6–8 hours prior to surgery, and will allow a light breakfast for those children whose surgery is scheduled in the late afternoon.

The current preoperative fasting guidelines at The Children’s Hospital of Philadelphia (Box 12-2) are a result of a compilation of a large amount of circumstantial evidence based on surrogate outcome variables - residual gastric volume and gastric pH. Since the severity of pulmonary aspiration is directly related to larger volumes and lower pH of the aspirate, anesthesiologists naturally prefer as empty as stomach as possible at the time of induction of anesthesia. However, the occurrence of the most important clinical outcome variable - pulmonary aspiration - has not been definitively associated with these surrogate outcome variables. Pulmonary aspiration of gastric contents is more closely linked with other factors such as emergency surgery, multiple intubation attempts, absence of neuromuscular blockade during intubation attempts, and the underlying medical condition of the patient.

### Box 12-2 Preoperative Fasting Guidelines at The Children’s Hospital of Philadelphia

| Clear liquids: until 2 hours prior to surgery |
| Breast milk: until 3 hours prior to surgery |
| Formula: |
| Infants <6 months – until 4 hours prior to surgery |
| Infants >6: until 6 hours prior to surgery |
| Non-human milk and solids: until 8 hours prior to surgery |

*a For those with disorders that can affect digestion, such as gastroesophageal reflux, diabetes, and recent trauma, more prolonged fasting recommendations may apply.

*b Healthy patients scheduled for surgery after 1300h are permitted to eat one of the following before 0700h: a single slice of dry toast (no butter, jam, peanut butter, or cream cheese, etc.) or up to one cup of dry plain Cheerios (no milk or yogurt). Having toast or plain Cheerios before 0700h may limit flexibility in the event of patient cancellation since anesthesia and surgery cannot in most situations start until 6 hours after eating these foods. To maximize a child’s chances of safely moving ahead in the surgical schedule, we recommend no solids after midnight and clear liquids up until 2 hours prior to surgery.

### Article To Know


It was not until 1990 that Mark Schreiner and his colleagues at The Children’s Hospital of Philadelphia published this landmark article that confirmed the safety of shortened preoperative fasting in children. They compared gastric fluid volume and pH in two randomly selected groups of 121 healthy children between 1 and 18 years of age. The control group received standard fasting orders which consisted of unlimited clear liquids up until 6 hours (≤5 years of age) or 8 hours (>5 years) prior to the scheduled time of surgery. The study group was allowed 8 ounces of a clear liquid up to 2 hours prior to the scheduled time of surgery. The important results are presented in the table below.

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Control Group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastric volume (mL/kg) (mean ± SD)</td>
<td>0.44 ± 0.51</td>
<td>0.57 ± 0.51</td>
</tr>
<tr>
<td>Gastric volume &gt;0.4 mL/kg</td>
<td>25/48 (48%)</td>
<td>59/67 (58%)</td>
</tr>
<tr>
<td>Gastric pH &lt;2.5</td>
<td>54/55 (97%)</td>
<td>44/48 (92%)</td>
</tr>
</tbody>
</table>


Using parental questionnaires, the investigators determined that children in the study group were significantly less irritable compared with children in the control group, and the parents of the children in the study group were significantly more satisfied. This study was one of the first to demonstrate that shortened preoperative fasts were no less safe than prolonged fasting, by the surrogate outcome measures of gastric volume and pH. Numerous additional studies have since confirmed these findings and extended the same results to infants younger than 12 months.
Children with a Potentially “Full Stomach”

Preoperative administration of pharmacologic agents effectively reduces gastric volume and increases gastric pH in children at the time of induction of anesthesia. These include H₂ receptor antagonists such as cimetidine, ranitidine, and famotidine, and prokinetic agents such as metoclopramide. Various regimens of each have been shown to decrease gastric volume and increase gastric pH in children. None, however, has been associated with a decreased risk of pulmonary aspiration, or decreased severity of aspiration pneumonitis. Therefore, the practice of administering these medications to children is not routine in most pediatric centers.

PREOPERATIVE HISTORY

The preoperative history in children should focus on concurrent medical diseases and their treatment, currently administered medications, previous allergic reactions, previous administration of anesthetics, and family history of problems with anesthesia. A variety of concurrent medical diseases may influence the anesthetic technique. Few concurrent medications influence the anesthetic technique. Examples include anti-convulsants, which tend to shorten the duration of action of the aminosteroidal neuromuscular blockers. The history should elicit problems with previous anesthetics. Anesthetic complications that recur include airway obstruction, postoperative nausea and vomiting, and severity of postoperative pain. If an anesthesia record is accessible, it must be thoroughly reviewed. Finally, the history of anesthetic problems in the family is focused on detecting adverse reactions that may have represented malignant hyperthermia or unexpected prolonged paralysis that may represent familial pseudocholinesterase deficiency.

When anesthetizing a neonate, the preoperative history should also focus on the medical histories of the parents and the course of pregnancy and delivery. A variety of maternal medical conditions during pregnancy affect the newborn (Table 12-1). Furthermore, many different medications administered during pregnancy may potentially affect the health of the newborn (Table 12-2).

A history of an allergy to a medication is common in children presenting for surgery. All children who require insertion of tympanostomy tubes have been exposed to at least one type of antibiotic. Many of these children report development of a rash after administration of antibiotics with a penicillin, cephalosporin, or sulfa base. Children do not routinely undergo further diagnostic testing to determine the cause of the rash. Therefore, the anesthesia practitioner has no accurate way of determining the true allergic status of the child, other than by history, or report from the parent. Research studies have consistently shown that history of a drug allergy does not accurately predict positive skin testing. In many cases, more detailed questioning of the parent reveals that the reaction was truly not allergic in nature. For example, a parent may report that their child is allergic to morphine because it caused their child to experience somnolence or itching. Anesthesiologists must take an allergic history seriously, for the very reason that we rarely, if ever, have firm indications for any type of medication, especially antibiotics. In other words, we always have other viable alternatives, although they may not necessarily be cost-effective. On the other hand, the indiscriminant use of more powerful antibiotics (e.g., vancomycin for Gram-positive cocci prophylaxis) leads to the development of antibiotic resistance. One of the most common examples of this is the child who presents with a history of an amoxicillin-related rash, and now requires surgical prophylaxis with cefazolin. The skin-testing literature suggests that the cross-reactivity between (true) penicillin and cephalosporin allergies is approximately 10%.

### Table 12-1 Maternal Medical Conditions and their Effects on the Newborn

<table>
<thead>
<tr>
<th>Maternal Medical Condition</th>
<th>Effect on Newborn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>Increased incidence of congenital anomalies, hypoglycemia, macrosomia, polycythemia, cardiomyopathy, hypocalcemia, immature lung disease, hypomagnesemia, hyperbilirubinemia</td>
</tr>
<tr>
<td>Oligohydramnios</td>
<td>Renal anomalies, fetal distress, growth retardation</td>
</tr>
<tr>
<td>Polyhydramnios</td>
<td>Tracheoesophageal fistula</td>
</tr>
<tr>
<td>Low α-fetoprotein levels</td>
<td>Trisomy 21 (Down syndrome)</td>
</tr>
<tr>
<td>Rh sensitization</td>
<td>Hydrops fetalis, or mild forms of hemolytic anemia</td>
</tr>
<tr>
<td>Antepartum bleeding</td>
<td>Anemia, hypovolemia</td>
</tr>
<tr>
<td>Premature membrane rupture</td>
<td>Neonatal infection, sepsis</td>
</tr>
<tr>
<td>Meconium-stained amniotic fluid</td>
<td>Interstitial pneumonitis</td>
</tr>
<tr>
<td>Systemic lupus erythematosus (SLE)</td>
<td>Congenital third-degree heart block</td>
</tr>
<tr>
<td>Myasthenia gravis</td>
<td>Neonatal myasthenia</td>
</tr>
<tr>
<td>Poor fetal heart rate tracing: late decelerations, poor beat-to-beat variability</td>
<td>Neonatal metabolic acidosis and effects from hypoxia</td>
</tr>
<tr>
<td>Preecclampsia</td>
<td>Neonatal neutropenia and thrombocytopenia</td>
</tr>
<tr>
<td>Graves’ disease</td>
<td>Hypothyroidism or hyperthyroidism</td>
</tr>
<tr>
<td>Chorioamnionitis</td>
<td>Neonatal infection, sepsis</td>
</tr>
</tbody>
</table>

When the penicillin allergy is based on history alone, the incidence is much less, and when reactions occur, they are rarely life-threatening. Although there is some room for flexibility, such as the child with mild allergic manifestations to penicillin who may then receive a cephalosporin, there are also some firm absolutes:

1. Never administer a medication for which a child has a history of a true allergy to that same medication.

2. There is no role for desensitization, or test dosing, in the perioperative setting. If the case arises where the surgeon insists on a particular medication for which the child has claimed an allergy, consultation with a specialist in immunology or allergy is then indicated.

**PREOPERATIVE PHYSICAL EXAM**

The focus of the preoperative physical exam is on the cardiovascular system, respiratory system, neurologic function, and other indicators of normal function (Table 12-3). These include evaluation for anemia, hypovolemia, and bleeding tendencies, among others. Normal findings on physical exam will vary with age in pediatric patients.

Examination of the cardiovascular system begins with a measurement of vital signs such as heart rate and blood pressure. Normal values for heart rate and blood pressure vary with age, gender, weight, and height (see Chapter 1). Many active and irritable infants will not cooperate with a preoperative physical exam and thus blood pressure measurements are unreliable, and probably irrelevant in otherwise healthy children. Auscultation of the heart should be performed to ascertain the presence of normal heart sounds and absence of unexpected abnormal murmurs.

One of the most vexing issues in pediatric anesthesia is the approach to the child with a heart murmur on preoperative physical exam. The parents should be queried as to whether or not the murmur has been previously detected by any of the child’s medical caretakers, and if there was any previous cardiac evaluation. If the murmur was previously detected, the anesthesiologist should determine its cause. In the vast majority of cases, the parent will acknowledge that the murmur has been deemed to be a normal flow murmur. If the murmur has not been previously detected, the anesthesiologist is confronted with a situation whereby he or she must decide rather quickly whether or not to continue with the anesthetic or cancel the case pending cardiology consultation to determine the cause of the murmur. The vast majority of

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**Table 12-2** Maternal Medications and their Effects on the Newborn

<table>
<thead>
<tr>
<th>Medication</th>
<th>Effect on Newborn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin and other NSAIDs</td>
<td>Hemorrhage, pulmonary artery</td>
</tr>
<tr>
<td></td>
<td>hypertension</td>
</tr>
<tr>
<td>Opioids</td>
<td>Neonatal depression, or abstinence</td>
</tr>
<tr>
<td></td>
<td>syndrome if chronic maternal usage</td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>Hyperbilirubinemia</td>
</tr>
<tr>
<td>Sulfonamides</td>
<td>Hyperbilirubinemia</td>
</tr>
<tr>
<td>Anticonvulsants</td>
<td>Congenital anomalies</td>
</tr>
<tr>
<td>Warfarin (coumadin)</td>
<td>Congenital anomalies, developmental delay, seizures</td>
</tr>
<tr>
<td>Antithyroid medications</td>
<td>Hypothyroidism</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>Neonatal bradycardia, hypoglycemia</td>
</tr>
<tr>
<td>Cocaine</td>
<td>Congenital anomalies, placental abruption</td>
</tr>
<tr>
<td>Magnesium sulfate</td>
<td>Respiratory depression, hypotonia, sensitivity to neuromuscular blockers</td>
</tr>
<tr>
<td>Ritodrine</td>
<td>Neonatal hypoglycemia</td>
</tr>
<tr>
<td>Terbutaline</td>
<td>Neonatal hypoglycemia</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Fetal alcohol syndrome: dysmorphic facies, growth retardation, developmental delay</td>
</tr>
<tr>
<td>Tobacco</td>
<td>Prematurity, IUGR, placental abruption and previa</td>
</tr>
<tr>
<td>Lithium</td>
<td>Cardiac anomalies</td>
</tr>
<tr>
<td>Isotretinoin</td>
<td>Micrognathia, cardiac and CNS anomalies</td>
</tr>
<tr>
<td>ACE inhibitors</td>
<td>Hypotension, oliguria</td>
</tr>
</tbody>
</table>

**Table 12-3** Key Elements of the Preanesthetic Physical Exam in Children

<table>
<thead>
<tr>
<th>Observation</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
</tr>
<tr>
<td>Hypotonia or hypertension</td>
<td>Neurologic or metabolic disease</td>
</tr>
<tr>
<td>Cyanosis</td>
<td></td>
</tr>
<tr>
<td>PALLOR</td>
<td></td>
</tr>
<tr>
<td>Anemia, poor cardiac output</td>
<td></td>
</tr>
<tr>
<td><strong>Cardiovascular</strong></td>
<td></td>
</tr>
<tr>
<td>Abnormal murmur</td>
<td>Congenital heart disease</td>
</tr>
<tr>
<td>Abnormal or absent pulses</td>
<td>Coarctation of the aorta, poor cardiac output</td>
</tr>
<tr>
<td><strong>Respiratory</strong></td>
<td></td>
</tr>
<tr>
<td>Tachypnea, abnormal lung</td>
<td>All are nonspecific findings in a variety of respiratory or cardiac disorders</td>
</tr>
<tr>
<td>sounds (e.g., wheezing,</td>
<td></td>
</tr>
<tr>
<td>rales, rhonchi), use of</td>
<td></td>
</tr>
<tr>
<td>accessory muscles of</td>
<td></td>
</tr>
<tr>
<td>respiration, grunting</td>
<td></td>
</tr>
<tr>
<td><strong>Head and Neck</strong></td>
<td></td>
</tr>
<tr>
<td>Abnormal craniofacial</td>
<td>All are indicators of possible difficulties with ventilation or intubation</td>
</tr>
<tr>
<td>formation (e.g., micrognathia)</td>
<td></td>
</tr>
<tr>
<td>limited mouth opening and</td>
<td></td>
</tr>
<tr>
<td>jaw mobility, limited neck</td>
<td></td>
</tr>
<tr>
<td>mobility</td>
<td></td>
</tr>
</tbody>
</table>

murmurs in otherwise healthy children can be classified as normal flow murmurs. These are not louder than II/VI, are usually vibratory in nature, and occur in systole over the pulmonary or mitral areas of the chest wall. Cardiology consultation should be obtained if these characteristics are not present, or if there are other findings relevant to the cardiovascular system on history or physical exam (Box 12-3).

Important elements of the respiratory system include the upper and lower airways. Facial structure and mandibular mobility should be examined for clues to a possible difficult ventilation or difficult tracheal intubation. Loose teeth should be suspected in children between 5 and 10 years of age. The anesthesiologist should manually remove an extremely loose tooth after induction of anesthesia as a precaution against its unintentional removal during airway manipulation and dislodgment into the bronchial tree. The lungs should be auscultated to ensure normal respiratory rate and breath sounds. Children with a history of reactive airway disease and those with a concurrent upper respiratory tract infection should be assessed for expiratory wheezing. Room air pulse oximetry should be performed; a value less than 96% should warrant an investigation of respiratory-related abnormalities. In general, respiratory rates greater than 44 breaths per minute are considered abnormal, except in otherwise healthy neonates and small infants, in whom normal breathing rates can occasionally reach 70 breaths per minute.

Additional elements of the physical exam will be largely dependent on the preexisting medical condition of the child and the nature of the surgery. For example, a focused neurologic exam is indicated prior to any neurologic or orthopedic surgery, and in children with neuromuscular diseases.

### Box 12-3 Reasons to Obtain Cardiology Consultation for a Previously Undetected Heart Murmur

#### History
- Poor exercise tolerance (or feeding intolerance in an infant)
- Patient was supposed to have a cardiology evaluation but it was never done
- Congenital heart disease in immediate family
- Cyanotic episodes

#### Physical Exam
- Murmur present in diastole
- Grade III or louder
- Absent or abnormal peripheral pulses
- Cyanosis, pallor, or poor capillary refill

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**PSYCHOLOGICAL PREPARATION OF THE CHILD**

The preoperative period is often a stressful and anxiety-provoking phase for the child and his or her family. It is not unusual for the parents to be frightened and to project their fears and anxiety on the child, thereby unintentionally contributing to the child’s fear and stress. Anesthesiologists must recognize these interactions and play a proactive role in preventing or treating the entire family’s concerns. As pediatricians often treat the parents more than the child, the pediatric anesthesiologist also often assumes a role as a “family practitioner.” It is extremely useful for the anesthesiologist to establish rapport with the child, which will then reassure the parents. More than anything, parents (and hospital staff!) will observe the anesthesiologist to ensure that he or she interacts well with the child and tries to relate on the child’s level. A very common complaint from parents and nurses is that although the anesthesiologist was very thorough in preoperative discussion with the parents, he or she did not attempt to interact with the child.

One of the most important considerations in pediatric anesthesia is an understanding of age-appropriate behaviors in response to external situations. Once these are recognized, anesthesiologists are able to tailor individual therapy to children and their parents (Table 12-4).

The most important outcome variables related to preoperative distress in children are postoperative behavioral disorders. These include, but are not limited to, sleep disturbances (e.g., nightmares), feeding difficulties, apathy, withdrawal, increased level of separation anxiety, aggression toward authority, fear of subsequent medical procedures and hospital visits, and regressive behaviors such as bed wetting. Although these disturbances are primarily present within the first two postoperative weeks, in some children they may last for many months. Much has been made of this issue in the recent literature, but the concept is not new. In 1953, Eckenhoff demonstrated that personality changes in children occurred and were associated with younger age and unsatisfactory inductions.

Dr Zeev Kain and his colleagues at Yale University School of Medicine comprehensively evaluated the characteristics of children with postoperative behavioral disorders and potential interventions. Children with a high level of preoperative anxiety were found to be at highest risk for these maladaptive behaviors, as were children who underwent “stormy” inductions. Furthermore, children with an extremely high level of preoperative anxiety...
had higher excitement scores on arrival to the postanesthesia care unit.

Many different modalities have been utilized in an attempt to decrease fear and anxiety in patients and their families. Behavioral interventions include preoperative informational materials that consist of discussions, tours, written literature, and videotapes. In some institutions, personnel from the Child Life department assume an active role in development of these programs and coordinate their efforts with anesthesia personnel. Some centers allow parents to accompany their child into the OR during induction of anesthesia in an attempt to allay anxiety. In carefully performed and controlled studies, however, these aforementioned interventions do not fare much better than placebo in decreasing the incidence of postoperative behavioral disturbances. Premedication with an anxiolytic drug such as midazolam is the only proven intervention to decrease these undesirable outcomes (Fig. 12-1).

Dr Chris Abajian at the University of Vermont has popularized the use of simple magic tricks for allaying preoperative anxiety in children. We have adopted many of these in our own practice to the delight of the patients, families, and our coworkers. The easiest and most basic is to use is the Fun Magic Coloring Book, in which the magician is easily able to turn a normal-appearing coloring book into a fully colored one with the flip of a page.

To date, outcome studies using magic as a preoperative anxiolytic technique have not been performed.

### PSYCHOLOGICAL PREPARATION OF THE PARENTS

#### Allaying Parental Anxiety

One of the most important preoperative jobs of the pediatric anesthesiologist is to attempt to allay anxiety in the parents and other family members. During the preoperative visit the anesthesiologist, while talking to the parents, should initiate contact and communication with the child. It does not matter if the child is too young to understand, or is too premedicated to remember any events. The parents will key in on the anesthesiologist's manner and how he or she relates to the child. Verbal cues such as smiling at the child, or asking the child simple questions, will reassure the parents that their son or daughter is in good hands. This practice will establish confidence and minimize parental anxiety.

#### Discussing Risks of Pediatric Anesthesia

A controversial issue in pediatric anesthesia is the extent to which the anesthesiologist should reveal the risks of anesthesia to the parents. Will this discussion...
increase or decrease parental (or child) anxiety? Should the anesthesiologist discuss the risk of death? What risks are appropriate to reveal? The answers to these questions are not easily found, and may partly depend on the informed consent laws of the state in which one practices. Studies universally demonstrate that anxiety is decreased with more information, even though that information may allude to more harmful risks. For example, in a questionnaire study, most parents whose anesthesiologist mentioned the risk of death indicated they were satisfied to hear about this rare risk. Many parents whose anesthesiologist did not specifically mention the risk of death indicated that it should have been mentioned.

This author’s practice is to allude to the potentially harmful, yet rare, risks of anesthesia without increasing anxiety by stressing the overall safety of the procedure. One such dialog to the parents of a healthy child for elective surgery is as follows: “I don’t expect any risks or complications. Of course, we can never say ‘never,’ but the risk of a life-threatening complication is extremely rare. Overall the anesthesia is extremely safe, and my job is to make sure it stays that way.”

Allowing Parents into the OR

The time of induction of anesthesia represents an enormously frightening time for both patients and parents. Many centers have promulgated a culture of allowing a parent to accompany their child into the OR during induction of general anesthesia. This has paralleled a trend to allow family members into other previously forbidden places where medical procedures are occurring, such as the emergency room or the ICU. Parents assert that they possess a right to be with their child during any and all phases of their child’s hospitalization. Studies have clearly shown that parental presence does not alter the acute behavioral distress of the child, nor does it alter outcomes such as negative postoperative behaviors. Furthermore, many parents are terrified as they observe the placing of a mask over their child’s face, watching their child become limp as consciousness is lost, and the occasional episode of upper airway obstruction that may occur. Yet when queried, parents who have been with their child in the OR during induction universally feel that they have done the right thing for their child and are more satisfied than if they didn’t participate. If a decision is made to allow a parent into the OR during induction, the anesthesiologist should fully explain the events that will occur during induction. Three major points should be addressed:

1. There should be an explanation of the nature of the procedure and the possible effects on the child (excitation, limpness, airway obstruction, etc.).
2. The parent must agree to leave immediately at any time when requested by an OR staff member.
3. The parent must agree to leave immediately once the child has lost consciousness. One of the surgical team members or another OR staff member should accompany the parent from the OR to the parents’ waiting area.

Some institutions will ask a parent to sign a written agreement to these terms, as well as a waiver of liability should the parent suffer an injury secondary to fainting or other adverse event.

PHARMACOLOGIC PREPARATION OF THE CHILD

Premedication of pediatric patients prior to induction of anesthesia can accomplish several goals, the primary one being anxiolysis, with a subsequent decrease in the incidence of postoperative negative behaviors. Other indications include preinduction of anesthesia, pain relief, drying of secretions prior to airway manipulation, vagolysis, and decreasing the risk for pulmonary aspiration of gastric contents. Preoperative sedation may be administered via any route, the most common being oral administration since the vast majority of children do not have an existing intravenous catheter. Rectal premedication is acceptable in toddlers, and in some centers the nasal route is preferred for midazolam. Few centers in the United States administer intramuscular premedication, or place intravenous catheters preoperatively.

A ground-breaking study on premedication in children was reported in 1959. Drs. Bachman and Freeman, at The Children’s Hospital of Philadelphia, successfully used intramuscular injections of various combinations of morphine, atropine, scopolamine, and pentobarbital. Children who received premedication exhibited improved ease of induction, reduced airway secretions, and less emergence delirium. In 1989, Susan Nicolson and her colleagues at The Children’s Hospital of Philadelphia challenged the necessity of intramuscular injections by reporting their positive experience with an oral premedication. This latter study marked the beginning of a new era of oral premedication, and an end to painful intramuscular injections in children.

There are various options for treatment of preoperative anxiety. None, however, are ideal – each has drawbacks. Basic principles of pharmacologic treatment of patients dictate that a drug should be administered to target its specific action, and not one of its side-effects. In other words, anxiety should be treated with an anxiolytic; pain should be treated with an analgesic, and so on. Therefore, it is generally unwise to treat anxiety using the sedative effects of an opioid. Unless there are no other options, a drug should not be used for its side-effects. For these reasons, it is best to treat preoperative anxiety with a medication that is specifically designed as
an anxiolytic. The benzodiazepines best fit this indication. Common options include midazolam, the most commonly administered premedication, and diazepam. In general, children above the age of 9 or 10 months will benefit from preoperative anxiolysis. Yet, some studies report that only 25% of children under 3 years of age are treated for preoperative anxiety. However, there is mounting evidence that preoperative anxiolysis can affect true patient outcomes in the form of decreased postoperative behavioral disturbances.

**Midazolam**

**Oral Midazolam**

Oral midazolam is the most common preoperative anxiolytic for children. This is because it possesses most of the properties of the ideal premedication (Box 12-4). The one exception is that it leaves a very bitter aftertaste when administered orally, even as a specially formulated oral syrup. Many children will attempt to spit it out of their mouth if it is not swallowed rapidly. After oral administration, the commercially available midazolam syrup is rapidly absorbed from the stomach. The absolute bioavailability of midazolam averages 36%, within a variable and large range (9–71%). This large range in bioavailability is consistent with most oral medications administered to children. In a large study, the plasma concentration/time curves of midazolam and its α-hydroxy metabolite were highly variable, and independent of the age of the child and the dose administered (Fig. 12-2).

Caution should be observed in children who are receiving erythromycin, since it can prolong the duration of action of midazolam via cytochrome P-450 inhibition. In children who are currently receiving erythromycin, the midazolam dose should be reduced by at least 50%.

Clinical sedative effects are seen within 5–10 minutes of oral midazolam administration, and appear to peak 15–30 minutes after administration. By 45 minutes, its sedative effects have dissipated in most children.

**Box 12-4 Desirable Characteristics of a Preoperative Anxiolytic**

- Effective and reliable anxiolysis and sedation
- Amnesia of preoperative events
- Facilitates induction of anesthesia
- Short latency period to onset of action
- Minimal respiratory and cardiovascular effects
- Easy to administer (for patient and staff)
- Short duration of action
- Blocks unwanted autonomic (vagal) reflexes
- Prevents excessive airway secretions

Pharmacodynamic studies indicate that sedation level is directly correlated with plasma concentration of midazolam. Plasma midazolam concentrations greater than 50 ng/mL are associated with adequate preoperative sedation. However, plasma concentrations of midazolam are not associated with anxiety scores at the time of mask induction of anesthesia.

The sedative effect of midazolam is best described as inebriation rather than sleepiness. Most children are happy, and will lose their balance. Therefore, after administration, children should be confined to a bed or in the confines of their parent’s arms, and be directly observed at all times by medical personnel. Clinically important cardiorespiratory side-effects are not observed in healthy children. Dysphoria may occur in some children. Anterograde amnesia is a favorable clinical effect following most doses of oral midazolam and may be responsible for the decrease in postoperative behavioral disturbances.

Most anesthesiologists find that an oral dose of 0.5–0.7 mg/kg results in the best clinical efficacy. However, recent pharmacodynamic studies suggest that a dose as low as 0.25 mg/kg results in reliable preoperative anxiolysis. There are no data to indicate the most appropriate maximum dose, but most anesthesiologists use between 10 and 20 mg.

Studies are conflicting, but some evidence indicates that midazolam premedication results in longer times to discharge postoperatively following surgeries of relatively short duration. Nevertheless, its preoperative advantages outweigh this disadvantage.
Nasal Midazolam

Nasal administration of midazolam can be accomplished in the form of nose drops or a nasal spray. The required dose (0.2–0.3 mg/kg) is lower than with oral administration and its reliability in producing anxiolysis is excellent. However, its administration is associated with an unpleasant burning of the nasal cavity and most children are quite upset following its use. In addition, plasma concentrations of midazolam are generally higher after nasal administration when compared to the oral route. Respiratory depression has been reported on occasion following nasal administration. For these reasons, the nasal route of administration is used infrequently by pediatric anesthesiologists.

Intravenous Midazolam

The intravenous form of midazolam is used when children present with an indwelling intravenous catheter prior to surgery. Since the intravenous form of midazolam is water-soluble, there is little pain on injection. Pharmacokinetic studies indicate a β-elimination half-life of less than 2 hours in children. The half-life of both midazolam and its major metabolite tend to increase with advancing age during childhood. The onset of intravenously administered midazolam is 2–3 minutes and the peak sedative effect is shortly thereafter. The duration of action varies between 2 and 6 hours, with most of the sedative effect dissipating within 30 minutes of a single dose. A standard intravenous dose of intravenous midazolam is 0.05 mg/kg, which can then be titrated to effect, depending on the clinical situation.

Rectal Midazolam

Rectal administration of midazolam in doses of 0.5–1.0 mg/kg effectively produces preoperative anxiolysis equivalent to that seen with nasal or oral administration. There is no specific rectal formulation - the intravenous formulation is most often used and can be diluted with water for injection into the rectal cavity. Children 3 years of age and less are most amenable to this route of administration. The child should be placed prone and the midazolam administered via a lubricated red rubber catheter. Once administered, the buttocks should be held closed for several minutes to prevent immediate egress of the midazolam solution (a struggling and uncooperative child will immediately push out much of the injectate). A small amount of air can also be injected via the catheter to help advance the remaining midazolam solution into the rectal cavity.

Diazepam

Since the advent of midazolam, diazepam has not been used routinely for premedication of children. This is primarily due to its relatively long onset of action and greater duration of action. Diazepam may be indicated for children or adolescents who require anxiolysis prior to approximately 1 hour before surgery. It can be administered orally at a dose of 0.3 mg/kg. It should not be given intravenously because of the extreme pain associated with intravenous injection.

Clonidine

Clonidine, an α₂-adrenergic agonist, has been used as an orally administered sedative premedication in children. In doses between 2 and 4 µg/kg, oral clonidine will produce adequate sedation and anxiolysis prior to induction of general anesthesia. A distinct advantage of clonidine is its ability to decrease intraoperative anesthetic requirements. However, the onset of action of oral clonidine is greater than 90 minutes, so it may not be suitable for use in the ambulatory setting where children are not often present in the facility prior to this time. Furthermore, when compared with oral midazolam for children undergoing tonsillectomy, clonidine is less effective as an anxiolytic at the times of separation of the child from the caretaker and of induction of anesthesia. An additional disadvantage of clonidine is its ability to blunt the heart rate response to administration of atropine. For these reasons, clonidine is not used routinely as a premedication in children.

Ketamine

Ketamine is gaining popularity as a premedication in children, in both the oral and rectal forms. At a dose of 5 mg/kg, it reliably produces a state of sedation and disassociation within 20 minutes of its administration. Larger doses have been associated with more reliable anxiolysis at the expense of longer postoperative times to awakening and discharge home. Advantages of its use include a low incidence of respiratory depression, and a possible decrease in intraoperative anesthetic requirements. It also possesses analgesic and amnestic properties. Disadvantages include an increased incidence of oral and airway secretions, an increased incidence of postoperative emesis, and a possible association with adverse psychologic reactions such as delirium, dysphoria, nightmares, and hallucinations. These latter effects have not been observed when ketamine has been used as a premedication. To date, studies have not demonstrated any clear advantages of ketamine over midazolam as a premedication in children. However, it may be a useful substitute in children known to exhibit dysphoric reactions to midazolam, or as an additive to midazolam in children who may be in pain, or difficult to calm.

Intramuscular ketamine is used when children are unusually combative and refuse all attempts at medical attention, including refusal to ingest an oral premedication.
It is most often used in developmentally delayed adolescents, who are unable to understand their circumstances and who may be difficult to physically restrain. To reduce the overall volume of the amount injected, the concentrated form of ketamine (100 mg/mL) should be used. Doses range from 2 to 6 mg/kg. Larger doses will result in greater reliability of anxiolysis and dissociation at the expense of longer times to emergence from general anesthesia, especially for surgeries of relatively short duration. This author prefers a lower dose with the modest goal of obtaining sufficient sedation to facilitate intravenous catheter insertion. Varying amounts of midazolam may be added to the injectate to attenuate possible postoperative psychologic disturbances. Some anesthesiologists will include atropine in the injectate in an attempt to reduce airway secretions.

**Methohexital**

Rectal administration of methohexital is an effective premedication in children. The powdered drug is dissolved in water to make a 10% solution, and administered at doses of 20–30 mg/kg. After its administration, most children will fall into a deep sleep within 15–20 minutes. Pharmacokinetic studies have demonstrated peak plasma concentrations between 10 and 15 minutes after administration, and a terminal half-life of 1–2 hours. Some children will attain a relatively deep level of unconsciousness after administration of rectal methohexital. Therefore, these children should be closely supervised by medical personnel after its administration. Respiratory depression is occasionally observed. Seizures have also been reported. Other complications include hiccoughs, defecation, and lack of sufficient efficacy, which is probably related to the inconsistent vascular absorption because of stool in the rectal vault.

**Fentanyl Orulet**

The fentanyl orulet, formally known as oral transmucosal fentanyl citrate (OTFC), is essentially a “lollipop” form of drug administration that has been marketed for its natural appeal to children. Moreover, it does not possess the unpleasant aftertaste associated with the oral formulation of midazolam. Since fentanyl is relatively lipophilic, it readily crosses into the bloodstream across the mucosal barrier of the oral cavity. Peak blood levels are usually achieved within 15–30 minutes after onset of sucking. If chewed or swallowed, it will lose its efficacy, as the bioavailability is then decreased. Pharmacokinetic studies in children indicate a wide variability in times to peak plasma concentration. The dose most often associated with adequate sedation is 10–20 µg/kg. Although its use is associated with significant sedation, its anxiolytic effects are limited and are generally not as effective as with midazolam. Furthermore, it causes bothersome facial pruritus in many children, respiratory depression in a minority of children, and an increased incidence of postoperative nausea and vomiting. For these reasons, the fentanyl orulet remains unpopular for premedication in children, unless the child is suffering from ongoing pain, and does not have available intravenous access. The major drawback to the use of an opioid as a premedication is that, unless the child is in pain, then we are relying on its side-effects, rather than its intended use. In general, when one uses a medication for its side-effects, its efficacy is less predictable.

**Anticholinergics**

In the past, anticholinergic drugs such as atropine and glycopyrrolate were routinely administered to children in the preoperative period. The major indication was to prevent undesirable episodes of bradycardia associated with administration of halothane or succinylcholine. An additional indication was to prevent vagally induced bradycardia during airway manipulation in neonates and small infants. Since halothane and succinylcholine are no longer routinely used in children, anticholinergic premedication is no longer routinely administered. However, many pediatric anesthesiologists may include intravenous atropine at the beginning of induction of anesthesia when using succinylcholine for full-stomach precautions, or when anesthetizing neonates. One disadvantage to the use of atropine is its ability to cross the blood–brain barrier and cause nonspecific anticholinergic central effects. These are manifested in infants in the postoperative period as irritability and crying for up to several hours. An additional theoretical disadvantage of atropine is its propensity to lower esophageal pressure within 2 minutes of its administration. This may increase the risk of passive regurgitation of gastric contents into the esophagus.

**ADDITIONAL ARTICLES TO KNOW**


