Chapter 12
Preanesthetic Preparation of the Pediatric Patient

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Preoperative considerations are described in this chapter and include assessment of the patient, and decisions concerning premedication, preoperative fasting, and preoperative laboratory tests. But the preoperative period is also the time when intraoperative and postoperative concerns are contemplated, and management plans devised.

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 (in healthy children this may occur on the day of surgery). Once these are reviewed, the anesthesiologist must then focus on alleviating stress and anxiety of the patient and family, who are usually talking on their cell phones and watching TV. To help with resident case preparation, we prefer a system called the 11 P's, so they don't forget any aspect of the case to discuss with their attending the night before (although there are always attendings that will find things they miss!). The 11 P's are divided into preoperative, intraoperative, and postoperative considerations.

The Eleven P's: What to Discuss With Your Attending Before the Case

1. Patient
   Discuss the patient's history, physical exam, previous anesthetics, and implications of any comorbidities.
2. Procedure
   Discuss the procedure and its considerations for anesthetic management.
3. Premedication
   Discuss the type and dose of premedication.
4. Preoperative Fasting
   Discuss the fasting orders. Healthy children should be encouraged to drink clear liquids up to 2 hours prior to the scheduled procedure time.
5. Preoperative labs
   Appropriate tests are chosen depending on the medical condition of the patient and the nature of the surgery.
6. Perioperative monitoring

Additional monitors are obtained if dictated by the medical condition of the patient or the nature of the surgery

7. Perioperative fluids
   Appropriate IV fluids are chosen depending on the age and medical condition of the child, and nature of the surgery.
8. Positioning
   Preparations are made to enhance patient safety when using a position other than supine.
9. Plan
   An anesthetic plan for induction, maintenance, and emergence from general anesthesia is formulated based on a combination of the above factors.
10. Pain
    Plans are formulated for intraoperative and postoperative analgesic requirements. This often includes a regional anesthesia technique.
11. 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.

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 infants under a certain age, usually around two to four months. Unfortunately, there are little or no data to guide current recommendations for obtaining preoperative hemoglobin values in this age range. 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 bleeding disorder in the child or their family. Some otolaryngology surgeons, however, will require these tests prior to elective tonsillectomy. A recent study suggests that using thromboelastography may be more reliable than the classic coagulation profile to assess coagulation in neonates.

Preoperative Fasting

Multiple studies 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 two 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 advantage to allowing ingestion of clear liquids less than two hours prior to surgery. Maintaining a two-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 in a liquid will delay gastric emptying, and the presence of pulp in a fruit juice may worsen an aspiration episode. 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. Besides, it's made from horse hooves and should generally be avoided in life (pectin is the vegetarian substitute, in case you were wondering).

Children should be actively encouraged to drink clear liquids two hours before induction of anesthesia. Advantages to this practice include a decreased risk of hypovolemia and hypoglycemia at the time of induction of anesthesia, decreased irritability of the child, and increased parental satisfaction.

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 eight ounces, and others have allowed unlimited amounts. The amount of clear fluids ingested two 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 three 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 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 four hours in most children. When compared to infants allowed clear liquids up to two hours before surgery, infants who ingest formula four hours prior to surgery have similar values for gastric volume and pH. Therefore, infants should be allowed to ingest formula up to four hours prior to surgery. Obesity does not adversely affect residual gastric volumes or gastric pH.

Gastric emptying of solids is more difficult to study in pediatric patients. Most institutions allow solids until eight 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 re a result of a compilation of a large amount of circumstantial evidence based on the surrogate outcome variables of 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 a stomach as possible at the time of induction of anesthesia. However, the occurrence of pulmonary aspiration, the most important clinical outcome, has not been definitively associated with these surrogate outcome variables. Rather, 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.

There is divided opinion about the most appropriate fasting interval following gum chewing. While this activity may comfort some children and may encourage gastric emptying, some studies demonstrate increased gastric volumes after gum chewing, and some anesthesiologists fear a dangerous aspiration potential risk if the gum wad is swallowed. Overall, the benefits of preoperative gum chewing up until the time of the administration of premedication most likely outweigh the risks.

CHOP PREOPERATIVE FASTING GUIDELINES

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

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 six 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 two hours prior to surgery.

Pharmacologic Adjuncts

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 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, and some concurrent medications influence the anesthetic technique. For example, anticonvulsants tend to shorten the duration of action of the aminosteroidal neuromuscular blockers. The history should elicit problems with previous anesthetics. Anesthetic complications that tend to recur include airway obstruction, postoperative nausea and vomiting, and severity of postoperative pain. If a previous 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 represent malignant hyperthermia or 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, and many different medications administered during pregnancy may potentially affect the health of the newborn.

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 the 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 indiscriminate 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. Unless the child developed hives from the amoxicillin, it is reasonable to administer a

cephalosporin. On the other hand, one should never administer a medication to which a child has a history of a true allergy. There is no role for desensitization, or test dosing, in the perioperative setting. If the case arises whereby the surgeon insists on a particular medication for which the child has claimed an allergy, consultation with a specialist in immunology or allergy is 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.

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. 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 had been previously detected by any of the child's medical caretakers, and whether there was any previous cardiac evaluation. If a cardiology specialist saw the child, the origin of the murmur should be documented. If the murmur has not been previously detected, the anesthesiologist is confronted with a situation whereby he or she must quickly decide 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 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.

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
Systolic murmur grade III or louder
Absent or abnormal peripheral pulses
Cyanosis, pallor, or poor capillary refill

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 five and 10 years of age. The anesthesiologist should manually remove an extremely loose tooth after induction of anesthesia as a precaution against its unintentional dislodgement and passage 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.

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 fear and anxiety on the child, thereby unintentionally contributing to the child's fear and anxiety. Anesthesiologists must recognize these interactions and play a proactive role in reassuring the entire family. As pediatricians often treat the parents more than the child, the pediatric anesthesiologist also often assumes a role as "family practitioner", but without the closet full of drug samples. The anesthesiologist should 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.

The most important outcomes related to preoperative distress in children are postoperative behavioral disorders. These include nightmarish sleep disturbances, 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 several months. Much has been made of this issue in the recent literature, but the concept is not new. In 1953, Eckenhoff demonstrated that postoperative personality changes were associated with younger age and unsatisfactory inductions.

During the preoperative informed consent process, it is helpful to know the modern-day risks of general anesthesia in children. A recent study at the Mayo Clinic revealed an incidence of cardiac arrest in anesthetized children (for noncardiac surgery) of 2.9 per 10,000, although when attributed only to anesthetic causes, the incidence decreased to 0.65 per 10,000 anesthetics. Very few of these patients were initially healthy prior to the procedure.

Dr. Zeev Kain and his colleagues at Yale University School of Medicine (he is now at UC Irvine) comprehensively evaluated the characteristics of children with postoperative behavioral disorders and potential preventative measures. 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 along with higher rates of emergence delirium.

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, the Child Life department assumes an active role in development of these programs and coordinates their efforts with anesthesia personnel. Some centers allow parents to accompany their child into the OR during induction of anesthesia. 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. Although distraction techniques are often effective, premedication with an anxiolytic drug such as midazolam is the only proven intervention to decrease these undesirable outcomes.

Dr. Chris Abajian at the University of Vermont popularized the use of simple magic tricks for allaying preoperative anxiety. We have adopted many of these in our own practice to the delight of the patients, families, and jealous coworkers. The easiest and most basic 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; however the distribution of toys to children aged three to six years, decreases their anxiety about taking premedication before anesthesia.

Psychological Preparation of the Parents

Allaying Parental Anxiety

One of the most important preoperative responsibilities of the pediatric anesthesiologist is 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. Asking the child about their interests, and performing a simple fist-bump maneuver, 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 one of us will always be there." Of course, comorbidities increase any risk. For example, the overall risk of respiratory complications is increased in children with obesity.

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 parental presence during induction of anesthesia (PPIA). This has paralleled a trend to allow family members into other previously forbidden places, 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. A recent survey showed that since 1995 the practice of PPIA or preoperative oral midazolam has grown significantly. The benefits of this practice are obvious as the child may feel safer with less anxiety if his or her parent is soothing them during induction in an unfamiliar location with masked care providers.

However, 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. Parental presence is not superior to preoperative sedatives such as midazolam for preoperative anxiety, and in certain patients may be associated with increased anxiety

when the child is calm and the parent is anxious. 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 happy to have experienced a sense of schadenfreude.

If a decision is made to allow a parent into the OR during induction, the anesthetist 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' smoking 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 calamity.

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 IV catheter. Rectal premedication is acceptable in toddlers, and in some centers the nasal route is preferred for midazolam. Few centers in the U.S. administer intramuscular premedication, or place IV catheters preoperatively.

In a groundbreaking study on premedicating children in 1959, Drs. Bachman and Freeman, at CHOP, 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, also from CHOP, 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. 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 (not an analgesic in the form of a lollipop); pain should be treated with an analgesic, and so on. A benzodiazepine is the best treatment for preoperative anxiety. Options include midazolam, the most commonly administered premedication, and diazepam. Children above the age of about nine months will benefit from preoperative anxiolysis because this is about the age of onset of separation anxiety from parents. Yet, some studies report that only 25% of children less than three years of age are treated for preoperative anxiety. There is mounting evidence that preoperative anxiolysis can affect true patient outcomes in the form of decreased postoperative behavioral disturbances.

CHARACTERISTICS OF THE IDEAL PREMEDICATION

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
Lowers intraoperative anesthetic requirement
Blocks unwanted autonomic (vagal) reflexes
Doesn't contribute to PONV

Midazolam

Oral midazolam is the most common preoperative anxiolytic for children. This is because it possesses most of the properties of the ideal premedication. The one exception is that it usually leaves a bitter aftertaste when administered orally, even as a specially formulated oral syrup and given with an apple juice chaser. Therefore, many children will attempt to spit it out 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. Approximately 14% of children that receive oral midazolam do not demonstrate effective anxiolysis.

Caution should be observed in children who are receiving erythromycin (or its derivatives), 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. 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 do not correlate with anxiety scores at the time of mask induction of anesthesia.

The sedative effect of midazolam is best described as inebriation rather than sleepiness. Therefore, after administration, children should be confined to a bed or 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, but may be seen in children at risk of upper airway obstruction. 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, a recent pharmacodynamic study showed 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 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, pediatric anesthesiologists tend use the nasal route of administration infrequently.

If a child has a preexisting IV catheter, it should be used to administer midazolam. Pharmacokinetic studies indicate a β-elimination half-life of less than two hours in children. The half-life of both midazolam and its major metabolite tend to increase with advancing age during childhood. The onset of IV midazolam is 2–3 minutes and the peak sedative effect is shortly thereafter. The duration of action varies between two and six hours, with most of the sedative effect dissipating within 30 minutes of a single dose. A standard dose of IV midazolam is 0.05 mg/kg, which can then be titrated to effect, depending on the clinical situation.

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 IV formulation is most often used and can be diluted

with water for injection into the rectal cavity. Children less than three years of age 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 - a struggling and uncooperative child will immediately push out much of the midazolam Santorum. 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 one hour before surgery. It can be administered orally at a dose of 0.3 mg/kg. It should not be given IV because of the extreme pain associated with injection.

Clonidine

Clonidine, an α_2-adrenergic agonist, has been tested 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, its onset of action is greater than 90 minutes, so it is not be suitable for use in the ambulatory setting. Furthermore, when compared with oral midazolam for children undergoing tonsillectomy, clonidine provides less anxiolysis at the time of separation of the child from the caretaker and at 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 can be used as a premedication in children, in both 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. 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 increased oral and airway secretions, an increased incidence of postoperative emesis, and a occasional association with adverse psychological 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 will not cooperate with IV catheter placement or inhalational induction. To reduce the volume of the amount injected, the concentrated form (100 mg/mL) should be used, in a dose of 2 to 6 mg/kg. Larger doses result in greater efficacy at the expense of longer times to emergence from general anesthesia, especially for surgeries of relatively short duration. We prefer a lower dose with the modest goal of obtaining sufficient sedation to facilitate IV catheter insertion or mask induction. Some anesthesiologists will include atropine in the injectate in an attempt to reduce airway secretions.

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 vagal-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 IV 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 two minutes of its administration. This may increase the risk of passive regurgitation of gastric contents into the esophagus.

Preoperative Intravenous Access

Although many children's hospitals utilize inhaled induction of anesthesia, anesthesiologists at some institutions prefer that children of a certain age receive an IV catheter prior to induction of general anesthesia. Distraction methods such as blowing up a balloon have been show to be efficacious for reducing the pain and anxiety that accompanies IV insertion. Topical anesthetics applied 60 minutes prior to venipuncture can also be partially effective. The J-Tip applicator is a needleless system that uses high pressure to apply intradermal local anesthetics and has better anesthetic effectiveness compared with EMLA®.

Upper Respiratory Tract Infection

Viral upper respiratory tract infections (URIs) are frequent in children, especially during the winter months. Typical symptoms include rhinorrhea, congestion, cough, fever, and malaise. Subclinical manifestations may include upper and lower airway edema, increased respiratory tract secretions, pneumonia, and bronchial irritability.

Intraoperative airway complications during general anesthesia appear to be more common

in children with a URI. These include coughing, laryngospasm, bronchospasm, and hypoxemia. Infants under 12 months of age tend to have more intraoperative complications than older children, and use of an endotracheal tube as compared with a facemask or laryngeal mask airway (LMA) increases the risk of these complications, but even LMA placement may be associated with complications in children with a URI. Passive exposure to cigarette smoke, and a history of atopy are additional risk factors.

In infants and children with a URI, apneic oxygenation is less effective; thus oxyhemoglobin desaturation may occur when, during rapid sequence induction, the child is not receiving positive-pressure ventilation.

Transient postoperative hypoxemia, postintubation croup, and postoperative pneumonia are probably more likely to occur in children with a URI. Long-term complications and true outcomes are difficult to define and quantify and may not differ between normal children and those with a current or recent URI.

With these possible complications in mind, when a child presents with a URI, it is intuitive that an elective procedure requiring general anesthesia should be canceled. But, because so many children have a concurrent URI at the time of their scheduled surgery, and long-term negative outcomes have not been demonstrated, this decision process is complex. How, then, should the anesthesiologist decide when to cancel an elective procedure in a child with a URI? First, one should assess the severity of the child's illness. The child with a runny nose without additional findings may be suffering from vasomotor or allergic rhinitis, which is usually not associated with perioperative airway complications. If it is clear that the illness is viral, one must then identify the factors that are likely to increase perioperative complications. These include:

> Significant coexisting medical disease (especially cardiac, pulmonary, or severe neuromuscular disease);
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> History of prematurity;
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> Lower respiratory tract signs (e.g., wheezing, rales);
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> High fever (>102°F);
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> Productive cough;
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> Major airway, abdominal, or thoracic surgery;
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> Parent is worried about proceeding; or…
>
> Surgeon is worried about proceeding (Ha!).

If any of these risk factors are present, it may be prudent to perform the procedure at a

later date when the child is in better health.

On the other hand, there are a variety of additional factors that may influence your decision to proceed with surgery or cancel the case. The most common reason for proceeding with a case even though risk factors are present is the presence of a URI that will likely continue without surgical intervention. This occurs when children require adenoidectomy or myringotomy to relieve chronic middle ear fluid collections. Non-medical factors that might sway you in favor of proceeding with the case are logistical family concerns, such as the parents taking a day off from work, difficulty obtaining day care, traveling a long distance at a great inconvenience to the family, etc. Since outcomes are not proven to be worse after surgery in children with a URI, these factors may play a role in the decision of whether or not to proceed. Most children who present with a URI have neither extremely mild symptoms nor severe symptoms. For these in-between children we must use our judgment to determine the proper course of action based on what we believe is best for the child.

Anesthetic management of the child with an active URI should be tailored to minimize airway irritability. Administration of a neuromuscular blocker to facilitate tracheal intubation will prevent laryngospasm. Humidification of airway gases may prevent the thickening of secretions that is commonly encountered in these children. Some authors suggest administration of an anticholinergic agent, such as atropine or glycopyrrolate, to attenuate vagally mediated airway complications; however, this remains untested. When feasible, facemask or LMA anesthesia is preferred over endotracheal intubation.

Some clues to the risks of URI can be gleaned by the results of a 2010 study in over 9,000 patients. A positive respiratory history (nocturnal dry cough, wheezing during exercise, wheezing more than three times in the past 12 months, or a history of present or past eczema) in a child with a URI was associated with an increased risk for intraoperative bronchospasm, laryngospasm, and perioperative cough, desaturation, or airway obstruction. In addition, a history of at least two family members having asthma, atopy, or smoking increased the risk for perioperative respiratory adverse events.

There is no consensus when to schedule elective surgery following an acute URI. In a 1979 publication that described the development of lower respiratory symptoms during general anesthesia in children with a URI, McGill and colleagues from DC Children's Hospital wrote: "the optimal period of recovery from the URI that should be allowed prior to considering the patient a candidate for an elective surgical procedure has not been defined." More than 30 years later, this is still true. Subclinical pathology, such as airway edema, atelectasis, and bronchial reactivity may remain for up to several weeks after the symptoms of the acute URI have resolved, depending on the specific type of viral agent. Three to four weeks seems to be a reasonable waiting time, but for many children this merely represents the period between successive illnesses.