Pediatric Anesthesia & Pain Management

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Guidelines for Pediatric Ambulatory Surgery

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Introduction

The utilization of same day surgery is increasing in virtually every medical center across the country, driven by cost-containment forces that are largely beyond our control or influence. In 1996, 26 per 1000 children of the same age group received care at an ambulatory facility. In 2006, 2.3 million children had ambulatory anesthesia for a total of 38 per 1000 (1). Children are excellent subjects for ambulatory surgical procedures because they represent a population that is largely healthy and free of chronic illness, they generally have caretakers (called parents) who are capable of assisting them at home through the recovery period, and because children would generally prefer to recover from their surgery in the comfort and security of their home, rather than the more anxiety provoking hospital environment. However, an inevitable result of this national trend is that we are seeing more chronic illness of childhood on the day of surgery, thus challenging us to adequately assess and prepare children preoperatively, devise and use anesthetic techniques that will enable our patients to be street-ready in a minimum period of time, while minimizing side effects and complications of anesthesia that might result in prolonged recovery room stays or inpatient hospitalization.

The most common procedures performed in the ambulatory setting in the community hospital are otolaryngologic, primarily myringotomy and tube insertion, tonsillectomy, and adenoidectomy, as well as common general surgical procedures including circumcision and inguinal herniorrhaphy. In the busier medical center with a referral pediatric surgical practice, additional cases commonly performed include eye muscle surgery, plastic repairs of cleft lips, urological procedures such as hypospadias repair, gastrointestinal endoscopy, radiological imaging procedures, and cardiac catheterization.

The purpose of this lecture is not to provide a broad overview of ambulatory surgery for children, but rather to update the clinician on recent advances and developments in this changing field.

Patient Selection and Preparation

Preoperative Screening:

The preoperative evaluation of the child undergoing ambulatory surgery is not different from the child undergoing inpatient surgery, and includes a full health assessment, physical examination, laboratory testing where indicated, etc.

Preoperative screening clinics for adult patients have been shown to be highly effective in eliminating unnecessary blood tests and radiographs, in reducing case cancellation, and in optimizing the preoperative condition of the patient. Their utility in pediatric ambulatory surgery seems intuitive, however there are no case series or studies that clearly establish their utility. Because most children who are presenting for ambulatory surgery are healthy, and would be classified ASA Physical Status 1 or 2, the preoperative screening clinic for children is primarily the opportunity for providing patient education and desensitization of the child to the hospital environment. Advanced ASA physical status does not preclude ambulatory surgery, but makes preoperative screening highly desirable so that the medical condition of the patient is optimal on the day of surgery.

Common problems that the anesthesiologist will face include:

The child with an intercurrent respiratory infection (URI)

Few questions in pediatric anesthesia prove to be so contentious and so frequent as what to do with the child with a cold. Economic forces generally favor performing surgery: the family may have taken time off from work to have surgery performed, relatives may have traveled from a distance to assist in family matters around the time of surgery, insurance authorization has been

obtained and may be time limited, surgeons have scheduled cases and have limited flexibility in rescheduling, etc. However, the weight of existing evidence indicates that children with active or recent upper respiratory infections have an increased incidence of adverse airway events, although these events tend to be mild and self limited. [2,3,4] The decision to cancel surgery of a child with an upper respiratory infection must take into consideration the following factors:

Table 1. Decision Making for The Child with a URI.

Factors favoring postponing surgery	Factors favoring performing surgery
Purulent nasal discharge	Clear "allergic" rhinorrhea
Upper airway stridor, croup	Economic hardship on family
Lower respiratory symptoms (e.g. wheezing, rales)	Exigencies of insurance and scheduling
Fever	Few and short "URI-free" periods
Infection control	Scheduled surgery may itself decrease frequency of URI's (e.g. T&A)

The Former Premature Infant:

Children born prematurely (before 37 weeks gestation) have an increased risk of postoperative apnea and episodes of desaturation. [5,6,7] While this is believed to be a consequence of residual effects of general anesthesia on the immature brainstem, the etiology of this complication is not fully defined, too little is known to recommend ambulatory surgery in this population even if a pure regional anesthetic is delivered.

The age at which the infant achieves brainstem maturity and is no longer at risk for postoperative apnea and arterial oxygen desaturation is not well defined, but is believed to be between 40 and 60 weeks of post-conceptional age. (The post-conceptional age is calculated as the sum of the gestational age and the chronological age.) The existence of significant post-neonatal problems, such as anemia, bronchopulmonary dysplasia, seizures, etc., make the infant more apnea-prone and should further delay surgery conducted on an ambulatory basis. Ambulatory surgery is therefore not appropriate in this population until this age has been reached, and surgery should either be performed on an inpatient basis with careful respiratory monitoring in the postoperative period, or should be delayed.

The Child with Sleep Apnea:

The commonest indication for tonsillectomy in children younger than 3 or 4 years of age is severe upper airway obstruction with or without sleep apnea. Children in this category have altered control of respiration because of chronic nocturnal hypoxia and hypercarbia, and respond in an unpredictable fashion to residual anesthetics and opioid medications in the recovery room. Furthermore, while one would expect airway obstruction and sleep apnea to rapidly resolve after removal of the tonsils, virtually all patients in this category have residual significant upper airway obstruction in the postoperative period that resolves over several days, and as many as 35% of children will ultimately not have significant improvement in sleep airway obstruction. In 1996 a study from Johns Hopkins Hospital demonstrated that children with (1) mild sleep apnea, (2) over the age of 4, and (3) without complicating conditions such as Trisomy 21 or craniofacial anomalies could be discharged home after tonsillectomy, while children outside of this group generally required electronic monitoring overnight after tonsillectomy. (8,9)

The Child with a Chronic Illness:

An increasing number of children with chronic illnesses are being seen in the ambulatory surgery setting. The following table illustrates a few of the more common problems that are seen, with some associated medical and anesthetic considerations:

Table 2. Some Common Chronic Medical Conditions in Children in Ambulatory Surgery.

Condition	Medical Considerations	Anesthetic Considerations
Seizure disorders	• Hepatic enzyme induction • Hepatic toxicity of anticonvulsants	• Preoperative determination of LFT's, anticonvulsant levels • Resistance to non-depolarizing NMB's
Asthma	• Steroid dependence	• Pre– and intra–operative bronchodilator Rx • Steroid augmentation
Cystic Fibrosis	• Nutritional deficiency • Chronic infection • Chronic lung disease • Asthma • Pulmonary hypertension	• Pre– and intra–operative bronchodilator Rx • Intraoperative pulmonary toilet • Control of pulmonary blood pressure
Congenital heart disease	• SBE prophylaxis • Chronic diuretic therapy– electrolyte alterations • Digoxin therapy	• Understanding anatomy of cardiac shunts • Altered anesthetic gas uptake • Avoidance of I.V. bubbles

Preoperative Laboratory Testing.

No routine testing is indicated in children. Rather, laboratory testing should be determined by the anticipated surgical procedure and its associated complications, and the preoperative condition of the child. Often, it is not necessary to subject the child to an additional venipuncture, rather blood can be obtained after induction of anesthesia and during placement of the intravenous cannula, for example to determine the hematocrit prior to tonsillectomy; other times, it is best to know the results of preoperative laboratory testing before embarking on an anesthetic, for example, in caring for children with complex or chronic disease states.

Table 3. Recommended preoperative laboratory testing.

Preoperative Condition	Laboratory Tests that may be Indicated
Black or Southeast Asian Ethnicity	• Hct; Hemoglobin, sickle cell screen • Hgb Electrophoresis if screen is positive or if anemic
Chronic seizure disorder	• LFT's; blood anticonvulsant levels
Congenital heart disease	• If history of CHF: CXR • If diuretic Rx: Electrolytes • If Dig Rx: K^+, Dig level
Diabetes mellitus	• Fasting blood glucose; Hgb-A1C
History of solid organ transplantation	• Creatinine
Leukemia or other malignancy Rx by chemotherapy	• Hct, platelet count; tests specific for toxicity of each chemotherapeutic agent being used
Pacemaker	• EKG
Prematurity	• Hct
Renal failure	• Electrolytes, Ca^{++}, Phosphate, BUN, creatinine, Hct
Tuberculosis + anti–Tb therapy	• CXR; LFT's

Premedication.

Premedication of children is very useful in achieving a calm and cooperative patient who does not struggle during induction of anesthesia, and in making the hospital experience less anxiety provoking for parents, patient, and anesthesiologist alike. Premedication is therefore most beneficial in the patient who is too young to voluntarily cooperate with the anesthesiologist, typically the child between 7–9 months and 8–12 years of age. Between the ages of 3 and 12 years, parental presence during induction of anesthesia often obviates the need for any premedication if the parents are calm and supportive and their presence will serve to calm the child. Parental presence in the induction room or operating room is a technique used in an increasing number of medical centers with success. [10,11,12]

Oral administration of midazolam has become the most often used premedicant in children, although it remains a very expensive alternative. In a dose of 0.5 mg/kg mixed with a vehicle to increase its palatability, it renders most children calm and cooperative while allowing them to

maintain consciousness and airway reflexes. Other commonly used premedications are listed in Table 4.

Table 4. Commonly used Oral Premedications for Children.

Agent, dose	Characteristics	Side Effects
Midazolam, 0.5 mg/kg	Anxiolysis, euphoria	Mild sedation, no increase in recovery time (12,13,14)
Clonidine, 4 mg/kg	Analgesia, sedation	Bradycardia, hypotension [15]
Dexmetomidine 4 mcg/kg	Analgesia, sedation	Bradycardia, hypotension [16,17]
Ketamine, 5 mg/kg	Dissociation, analgesia	Dysphoria, hallucinations [14]

Anesthesia Techniques and Agents for Ambulatory Surgery

General vs. General + Regional Anesthesia

While regional anesthesia without general anesthesia or deep sedation is seldom a viable alternative in children, regional anesthesia in combination with general anesthesia is frequently used. Why? Regional anesthesia adds to the complexity and anesthesia time in anesthetizing children, and also requires more time obtaining informed consent from the parents. Is this investment in time and effort worth the trouble in a busy ambulatory setting? Yes: the time investment up front is made up on the back end in several ways, including more rapid and smoother emergence from anesthesia and therefore quicker egress from the operating room, faster recovery times and discharge home from the hospital or surgery center, and greater personal and patient/parent satisfaction. [18, 19, 20, 21]

Suitable techniques for children include caudal blocks for surgery below the diaphragms, lumbar epidural blocks for abdominal or chest wall surgery, ilio-inguinal/iliohypogastric nerve blocks for herniorrhaphy and orchiopexy, penile nerve blocks for circumcision and hypospadias repair, and axillary nerve blocks for arm and hand procedures. The reader is referred to reviews in this and other volumes for details on the performance of these blocks.

The Role of New and Old Inhalation Agents.

In the past few years, 2 new inhalation agents have come to the American market, desflurane and sevoflurane. Both are halogenated ether molecules that have several theoretical advantages over the older agents in use: they are far less blood soluble than halothane and isoflurane, therefore will produce faster inhalation inductions and more rapid arousal.

Table 5. Comparison of Inhalation Agents for the Ambulatory Setting.

Agent (MAC in kids)	Advantages	Disadvantages	Recovery Characteristics
Isoflurane (2%)	• More expensive • Unpleasant irritating smell	• Coughing on induction and emergence	Slowest
Sevoflurane (2.5%)	• Rapid induction and emergence • Acceptable for mask induction • HR and BP maintained during deep levels of anesthesia	• Expensive • No demonstrative advantage in PACU discharge Times • Delirium and agitation on emergence [22]	Second fastest
Desflurane (6%)	• Least soluble, most rapid emergence • May reduce recovery time	• Expensive • Very Irritating To Airway: inappropriate for induction	Fastest

Management of Side Effects and Pain

Nausea and Vomiting

Beside pain, there is probably no more uncomfortable and distressing side effect of surgery and anesthesia than nausea and vomiting. Furthermore, several procedures commonly performed in the pediatric ambulatory setting are notable for very high rates of nausea and vomiting,

approaching 70% in unmedicated and untreated children. These include tonsillectomy, middle ear surgery, and eye muscle (strabismus) surgery. [23,24,25] Other risk factors have been defined for nausea and vomiting. Nausea and vomiting is less common in children under 3 years of age, and is more common in females than males, and in patients who are encouraged or required to drink fluids prior to discharge from the recovery room. [26]

Several agents have been tried and tested over the past decade for the prevention of nausea and vomiting. Metoclopramide, while not sedating, produces only a modest reduction in the incidence of nausea and vomiting. [27]

The literature is convincing that ondansetron alone or in combination with dexamethasone is useful in the prevention of nausea and vomiting. [28, 29, 30, 31] Finally, the literature is also convincing that alternative techniques are effective in reducing nausea and vomiting, including the selection of propofol as the anesthetic maintenance agent, and the avoidance of opioid analgesics in favor of nonsteroidal anti-inflammatory analgesics. [30, 31,32,33]

Table 6. Prevention of Nausea and Vomiting

Agent, dose	Side Effects
Dexamethasone, 0.1 mg/kg	Increased blood sugars, increased risk of postop infection
Metoclopramide, 0.1–0.25 mg/kg.	Infrequent extra-pyramidal effects
Ondansetron, 0.1 mg/kg,	Headache
Propofol anesthesia/TIVA	Hypotension

Postoperative Analgesia

Management of postoperative pain is an important feature of successful ambulatory anesthesia. The prevention of postoperative pain by the use of local anesthetic nerve blocks or local infiltration, or the intraoperative administration of one or more of the agents in Table 5, provides for smoother emergence from anesthesia and less agitation in the recovery room, and theoretically will inhibit central nervous system windup. The reactive administration of analgesics in the recover room is never as satisfactory as the prevention or obtundation of pain before it is perceived by the child.

In addition to the regional anesthesia techniques discussed above, alternatives for pain management include the following:

Table 7. Pain Management Techniques.

Technique	Advantages	Disadvantages
Acetaminophen 10-20 mg/kg p.o. 10-15 mg/kg IV	Effective for mild to moderate pain Useful primarily as adjunctive agent	Should be administered preoperatively or early in surgery
NSAID's, Ketorolac 0.5 mg/kg I.V.	Effective for moderate pain No nausea or vomiting	Increases bleeding associated with tonsillectomy [34,35] Contraindicated in the presence of asthma or renal disease
Intravenous Opioids	Very effective for moderate to severe pain	Associated with nausea and vomiting [36] Sedation; requires monitoring after administration
Oral Opioids	Effective for moderate to severe pain Oral preparation May be administered at home	Associated with nausea and vomiting, constipation
Regional Anesthesia	Reduces requirement for general anesthesia No nausea, vomiting Eliminates need for opioids	Neuraxial blocks may delay ambulation of older children Older children may object to having numb extremities Time-limited duration of action

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