

Children are excellent candidates for ambulatory (outpatient) surgery. Most children are healthy, and most surgical procedures performed on children are simple and associated with prompt recovery. It is not surprising, therefore, that up to 80% of pediatric surgery in this country is performed on an ambulatory basis. In fact, in many cases ***ambulatory surgery is now synonymous with elective surgery***. The key to the success of pediatric ambulatory surgery lies in careful selection, screening and preparation of prospective patients. Screening must be completed prior to the day of surgery. Anesthetic techniques should ensure smooth onset, prompt emergence, fast recovery and safe discharge with good control of postoperative pain and vomiting.

#### PATIENT SELECTION CRITERIA

A successful ambulatory surgery program requires that well-defined patient selection criteria be established, and strictly adhered to by all surgeons who have admitting privileges in the facility. The primary factors that must be considered when selecting a child for ambulatory surgery are the physical status of the patient, and the type of surgical procedure to be performed. These factors must be balanced with the capability of the surgical facility and the ability of its staff to deal with any expected or unexpected complications.

**The Patient:** The child should be in good health; if not, any systemic disease must be under good control. Today, Many patients with chronic medical conditions present for surgical procedures that are usually considered appropriate for ambulatory surgery. In these cases, an understanding of the underlying pathophysiology and thorough preoperative evaluation will help guide the anesthesiologists as to the appropriateness of choosing the type of ambulatory setting in each individual patient. Some of these conditions are discussed below.

**The premature infant** is not a suitable candidate for ambulatory surgery because of potential immaturity of respiratory center, temperature control, and gag reflexes. Several studies have reported a high incidence of perioperative complications such as apnea in these infants. The age at which a former premature infant (***ex-preemie***) attains physiologic maturity and no longer presents an increased risk for postoperative apnea remains controversial, and is best considered individually. It is generally considered that infants younger than 46 weeks postconceptual age (PCA) and/or preoperative history of apnea are at greatest risk; although some authors have reported apnea in infants as old as 60 weeks PCA. Many anesthesiologists admit to a hospital or to a 23 hr. recovery facility all ex-premature infants who are younger than 50-55 weeks post-conceptual age so that they may be monitored postoperatively for apnea, bradycardia, and oxygen desaturation. If the infant was extremely premature, has bronchopulmonary dysplasia (BPD), anemia or other neonatal problems, this period may need to be extended. It seems prudent to have a high index of suspicion when dealing with these infants, and to err on the side of recommending postoperative inpatient or 23 hr. recovery care and monitoring. Infants who develop apnea in the recovery room should also be admitted and monitored.

**The Child with a Runny Nose:** A child who presents with a runny nose may have a benign, noninfectious condition (e.g., seasonal or vasomotor rhinitis), in which case elective surgery may safely be performed. On the other hand, the runny nose may be an infectious process (URI), in which case elective surgery may need to be postponed. Since an estimated 20-30% of all children have a runny nose a significant part of the year, every child with a runny nose must be evaluated on an individual basis. The preanesthetic assessment of these patients consists of a complete history, a physical examination, and occasionally, an interpretation of certain laboratory data. In most cases, the history is the most important factor in the differential diagnosis. Specifically, allergic problems should be actively sought. Parents can usually tell whether their child's runny nose is "***the usual runny nose***" or an acute infection that may require cancellation of elective surgery. Parents of ambulatory patients can be instructed to call-in on the morning of surgery if the child develops URI symptoms so the findings can be reviewed and if a decision to cancel surgery is made, they are spared a wasted trip to the hospital. If surgery is postponed because of simple nasopharyngitis, it can be usually re-scheduled in one to two weeks. If a flu-like syndrome that involves both upper and lower respiratory tract is present, surgery should be postponed until at least a month after the child has recovered.

**Asthma** is the most common chronic disease of childhood, affecting 5-10% of children in the US, and the incidence is on the rise. It is not therefore unusual for patients with asthma to present for what is often a minor surgical procedure in an ambulatory setting. The decision to accept and proceed with such patients depends on the severity and frequency of symptoms and the adequacy of pharmacological control. Children with **mild asthma** who have infrequent symptoms and do not require continuous medications are excellent candidates for ambulatory surgery. When children with **moderate asthma** (those who require daily medications to control their symptoms) are

scheduled for ambulatory surgery, they should be instructed to continue their medications until (and including) the morning of surgery. A beta agonist should be administered in the holding area by a nebulizer to young children or by an inhaler if the patient is older. If the patient is wheezing, has co-existing URI, persistent cough or tachypnea on the day of surgery, it is best to reschedule the procedure. The choice of a specific anesthetic technique in an asthmatic child is usually dictated by the nature of the surgical procedure. Most anesthetics available today have been used successfully in asthmatics. The use of an LMA may decrease the incidence of intraoperative bronchospasm. If an endotracheal tube must be used, sufficient depth of anesthesia should be established first. Intravenous lidocaine and/or a beta agonist inhalant may be administered just before extubation. Deep extubation may be considered. Patients may leave the facility when the usual discharge criteria are met. Children should not have any signs of wheezing when discharged. Adequate hydration should be ensured.

**The Procedure:** Many experts believe that almost any operation that does not require a major intervention into the cranial vault, abdomen, or thorax can be considered for ambulatory surgery. The planned surgical procedure should be associated with only minimal bleeding and minor physiologic derangements. The length of the procedure is not in itself a significant limitation. The five most frequently performed ambulatory surgical procedures at Children's National Medical Center (CNMC) are herniotomies, myringotomy, adenoidectomy with or without myringotomy, circumcision, and eye-muscle surgery. Recent experience indicates that ambulatory *adenotonsillectomy* is also safe and cost-effective and that there is little benefit in keeping these patients in the hospital more than a few hours after surgery to ensure adequate hydration, pain relief and absence of bleeding. Many young children (< 3 yr.) who are undergoing tonsillectomy for the relief of severe airway obstruction, with or without sleep apnea (*OSAS*), continue to suffer from the same symptoms and exhibit worse apnea and desaturation in the immediate postoperative period and should, therefore, be admitted to a hospital or a 23 hr. recovery facility for close observation and monitoring postoperatively.

#### **PREOPERATIVE REQUIREMENTS AND SCREENING**

Most ambulatory surgical units actively participate in the preoperative screening of their patients. This can be accomplished by a simple telephone call to the parents a day or two prior to surgery, or the establishment of a formal screening clinic to "clear" all patients before surgery. At CNMC, the parents of each child are interviewed by telephone shortly after the operation is scheduled. A second call is made 24 hours or less before surgery. During the initial call, information is sought concerning past or present risk factors, such as a history of prematurity or cardiac or respiratory problems. This information helps to determine if additional preoperative evaluation or consultation is required prior to the day of surgery. In some cases, it may lead to a reevaluation of the appropriateness of scheduling the procedure on an ambulatory basis. During the second phone call, an assessment of the child's current health is made. NPO orders are reinforced, and practical matters related to parking, what to bring to the hospital, and expected duration of stay are explained. On the day of surgery, all patients are screened for acute illness and NPO status. Vital signs are recorded. Any consultation reports are evaluated, and the need for special preoperative psychological or pharmacologic treatment is considered before the child arrives into the operating room area.

#### **PREOPERATIVE PREPARATION**

The time between the patient's arrival at the facility and the induction of anesthesia is usually quite short. There is little time to orient the child to all the events that will take place during his or her stay. Many centers, therefore, encourage children and families to participate in presurgical preparation programs a few days before surgery, and studies have shown that children who attend these programs are much more cooperative during induction than those who do not.

#### **PHARMACOLOGIC PREMEDICATION**

The value of and need for pharmacologic premedication in pediatric outpatients is controversial. Although many children do not need preoperative sedation, provided that they have received proper psychological preparation and established a good rapport with the anesthesiologist, some do. Midazolam, which is now available as a commercially prepared syrup, can be administered orally in a dose of 0.5 mg/kg 20-45 minutes before induction to facilitate separation from the parents and improve the child's cooperation during induction. In this dose, midazolam has no, or minimal effect on the speed of recovery. When premedication is not used routinely, the anesthesiologist must be prepared to administer a rapidly acting preinduction agent (low-dose IM ketamine or nasal midazolam) to the occasional uncooperative or extremely frightened child.

### **PARENTS' PRESENCE DURING INDUCTION**

Since one of the main reasons for administering routine premedication, or having to resort to using a preinduction technique is to facilitate separation of the child from the parents, some anesthesiologists find that they can reduce the need for such agents by allowing the parents to stay with the child during the induction of anesthesia. This approach is gaining a lot of supporters, and is being requested by many parents. Some institutions have specially built induction rooms where the parents can accompany their children without having to wear special O.R. attire. Others allow selected parents to wear a cover-all gown or scrubs and walk with the child into the actual operating room. Studies have shown that children are less upset when the parents are present. Parents' selection and education are essential for the success of this approach, since anxious parents can make their children even more upset.

### **ANESTHETIC AGENTS AND TECHNIQUES**

The choice of an anesthetic technique for pediatric ambulatory patients should ensure smooth onset, quick emergence at the end of surgery, prompt recovery in the PACU, and rapid discharge with no or minimal pain and/or PONV.

**Inhalational Techniques:** Inhalational induction is a popular choice in pediatric anesthesia. Techniques that reduce the anxiety associated with inhalation induction, and therefore promote patient cooperation, include the use of transparent masks that are painted with a drop of food flavor of the child's choice and allowing the child to sit up during the induction.

*Sevoflurane* has a very pleasant smell, and is the least irritating inhalational induction agent available. It can be used for both induction and maintenance of anesthesia in children. Because of its low blood/gas solubility coefficient, sevoflurane results in extremely rapid and smooth induction with no airway irritation even when an 8% inspired concentration is used initially. Emergence and recovery times are faster when compared to halothane.

*Desflurane* is not indicated for start of anesthesia induction in children because it results in a high incidence of airway irritation, coughing and laryngospasm. Desflurane, however, can be easily introduced following other induction agents, typically sevoflurane. This results in significantly faster emergence and recovery than when halothane or sevoflurane are used. Emergence excitement is common following un-supplemented desflurane and sevoflurane anesthesia. This can be greatly decreased by including an opioid such as fentanyl in the anesthetic regimen. A recent study suggests that the use of desflurane for maintenance of anesthesia after sevoflurane induction in children is associated with less severe emergence agitation and faster emergence times.

**Intravenous Techniques:** Intravenous induction is the method of choice in many older children especially when EMLA is used to perform a painless venipuncture. The use of EMLA in outpatients requires careful planning, since at least one hour of contact time under an occlusive dressing is required for full effect. Efforts to have EMLA applied at home by parents should be encouraged. In most cases EMLA should be applied to two potential IV sites to have a back-up site available in case the first venipuncture is not successful.

Studies on the use of *propofol* in children indicate that it results in smooth induction with a lower incidence of side effects and faster recovery than thiopental. Propofol can be used in a dose of 2.5-3.5 mg/kg for induction of anesthesia in children who accept venipuncture. Pain on injection can be minimized or even prevented by using the large antecubital veins for the drug administration. If the hand veins must be used, lidocaine can be mixed with propofol (1-2 mg lidocaine / 1 ml of propofol) immediately prior to its injection, with excellent results. Recovery is fastest if propofol induction is followed by a propofol infusion for the maintenance of anesthesia. Because of their higher volume of distribution and increased clearance, children require a higher infusion rate (200-300 mcg/kg/min.) during the early part of maintenance than adults. Propofol is widely used in pediatric procedures requiring sedation, e.g., radiological examination. Strict compliance with the safe monitoring guidelines recommended by the ASA is mandatory to ensure safety. Use of propofol anesthesia for GI procedures is also commonly done in ambulatory patients.

Propofol anesthesia has been consistently shown to be associated with an extremely low incidence of postoperative vomiting even following surgical procedures that normally result in vomiting e.g., strabismus surgery.

**Anti-emetics:** Postoperative nausea is difficult to assess in children. Recent studies have shown that the occurrence of postoperative vomiting in children can be predicted using a duration of surgery longer than 30 minutes, age  $\geq 3$  years, strabismus surgery, and a positive history of postoperative vomiting in the child or PONV in mother, father, or siblings as major predictors. 5-HT<sub>3</sub> antagonists such as ondansetron have been studied in children, and shown to be effective for both the prevention and treatment of postoperative vomiting in ambulatory patients. A single IV dose (0.1 mg/kg for children < 40 kg; 4 mg for children > 40 kg) is recommended for both indications. Ondansetron is especially indicated in children undergoing such vomiting-prone procedures such as tonsillectomy or strabismus surgery, where more conventional antiemetics have little or no effect. A multi-modal approach including dexamethasone (0.15 mg/kg) and a 5-HT<sub>3</sub> antagonist can be combined with a propofol-based anesthetic for maximal benefit. The recent introduction of the orally disintegrating format of ondansetron (ODT) allows oral administration after discharge without the need of active swallowing.

For patients with persistent postoperative vomiting, our approach is to stop any attempt at offering oral fluids and ensure adequate intravenous hydration. Occasionally rectal promethazine 0.5 mg/kg (Phenergan 12.5-25 mg), or prochlorperazine 0.1 mg/kg (Compazine 2.5-5 mg) are administered in the hospital and/or given to the parents to use at home.

## PERIOPERATIVE FLUID MANAGEMENT

**Preoperative fasting:** Most pediatric anesthesiologists have liberalized NPO requirements for their patients. Solid food, which includes milk, formula and milk products, is still not allowed on the day of surgery. Breast-fed infants, however, are allowed to nurse up to 4 hours preoperatively. Children may drink clear liquids until 2 hours of the posted surgical time. It is important to note that these guidelines apply to clear liquids only (not solids) in otherwise healthy children. Possible benefits of shorter fasting times include minimizing thirst and discomfort while awaiting surgery, less hypovolemic-induced hypotension during induction and less concern about hypoglycemia.

The need for routine **administration of intravenous fluids** during pediatric ambulatory anesthesia is controversial. Children undergoing very brief surgical procedures (e.g., myringotomies) may not need any parenteral fluid administration as long as they are not excessively starved preoperatively, and are expected to be able to ingest and retain oral fluids soon after they are awake. For most other children, intraoperative maintenance fluid administration can be calculated based on the child's body weight according to standard formulae.

If continuing postoperative loss through vomiting or inability to tolerate PO intake is anticipated, it is advisable to start making up that anticipated deficit early on so that it is assured that the child is well hydrated when ready to go home, and therefore avoid delaying discharge while "catch-up" fluid administration is instituted. Adequate parenteral hydration also obviates the need for forcing children to ingest oral fluids before they are allowed to go home. Recent studies confirm that children who are forced to drink before leaving the facility have higher incidence of vomiting, and are discharged home later, than children who are allowed to drink only when they are thirsty enough to request a drink.

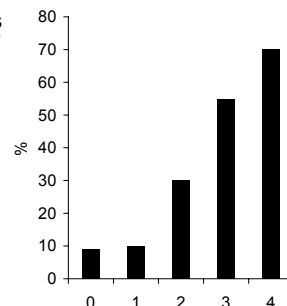
## POSTOPERATIVE ANALGESIA

The need for analgesics following surgery depends upon the nature of the procedure and the pain threshold of the patient. Regional blocks or local infiltration should be used whenever possible to supplement general anesthesia and to limit the need for narcotics during recovery. Postoperative pain or discomfort can be managed by one or a combination of the following methods.

**Acetaminophen** is the most commonly used mild analgesic for pediatric ambulatory patients. For young children, the initial dose is often administered rectally (40 mg/kg) prior to awakening from anesthesia. Supplemental doses are given orally (10-15 mg/kg every 4-6 hr; not as needed). The total daily dose should not exceed 100 mg/kg.

## Prediction of Pediatric PONV

Factors	Odds Ratios
Strabismus surgery	4.3
Age $\geq 3$ years	3.3
Duration surgery > 30 min	3.2
History PV (family, sib, pt)	4.2



Eberhart LHJ, et al. *Anesth Analg* 2004;99:1630-7

Acetaminophen can be combined with codeine for more effective control of moderately severe pain and/or discomfort. Acetaminophen with codeine elixir contains 120 mg acetaminophen and 12 mg codeine per 5 ml. The usual dose is 5 ml for children 3-6 years, and 10 ml for the 7-12 age group.

**Non-Steroidal Anti-Inflammatory Drugs (NSAID):** NSAIDs, e.g., ketorolac, have proved effective in relieving postoperative pain following minor operations in children. Early administration immediately following induction seems to provide optimal postoperative analgesia. Ketorolac, however, may increase the risk of surgical bleeding secondary to altered platelet function.

**Potent Narcotic Analgesics:** When narcotics are indicated in the recovery period, a short-acting drug should be chosen. Intravenous use allows more accurate titration of the dose and avoids the use of "standard" dosages based on weight, which may lead to a relative overdose. If remifentanyl is used intraoperatively, planning for postoperative analgesia must be started prior to awakening. Fentanyl, in a dose of 1 - 2 mcg/kg, is our drug of choice for intravenous use. Nasal fentanyl (2 mcg/kg) has been used successfully following BMT surgery.

**Regional Analgesia:** Regional anesthesia can be combined with light general anesthesia to provide excellent postoperative pain relief and early ambulation, with minimal or no need for narcotics. By placing the block before surgery starts but after the child is asleep, one can reduce the requirement for general anesthetic agents during surgery, which in turn may result in a more rapid recovery, earlier discharge, more rapid return of normal appetite, and less nausea and vomiting.

The types of blocks that can be used safely in the pediatric ambulatory surgical patient are limited only by the skill and interest of the anesthesiologist. Generally, the techniques chosen should be simple to perform, have minimal or no side effects, and not interfere with motor function and early ambulation.

**Ilioinguinal and iliohypogastric nerve block** can be performed by infiltration of 0.25 percent bupivacaine solution (in doses up to 2 mg/kg) in the region medial to the anterior superior iliac spine. This block has been used successfully to provide excellent postoperative analgesia for pediatric ambulatory patients following elective inguinal herniotomy, hydrocelectomy, or orchiopexy.

**Dorsal nerve block of the penis** can be performed by simple injection of 1-4 ml of 0.25 percent bupivacaine without epinephrine deep to Buck's fascia 1 cm from the midline. This has been shown to provide over 6 hours of analgesia following circumcision with no complications. Topical application of lidocaine on the incision site at the conclusion of surgery has also been shown to be effective.

**Caudal block**, using bupivacaine, 0.25 percent solution in a dose of 0.5-1.0 ml/kg, provides excellent postoperative analgesia following a wide variety of surgical procedures such as circumcision, hypospadias repair, orchiopexy, and herniotomy. When a larger volume is indicated, the use of a 0.125% solution is recommended. Alternatively, ropivacaine 0.2% solution can be used to provide similar duration analgesia, but less motor weakness than bupivacaine.

## DISCHARGE CRITERIA

Rapid recovery and early ambulation are major objectives in ambulatory surgery. When dealing with pediatric outpatients, we must guarantee safe discharge not only from the recovery room but also from the hospital. Traditional PACU recovery scoring tools have evolved to include pulse oximetry. The one used at CNMC is shown. A score of 9-10 indicates that the child is fit for discharge from PACU to a step-down unit, but not to home. Early experience with bypassing PACU, and allowing children to unite with their parents immediately after surgery (fast-tracking) suggest that discharge home is faster, and postoperative pain and vomiting are less frequent.

CNMC PACU Recovery Scoring Tool

	Score	Description
<b>Motor Activity</b>	2	Moves limbs purposefully
	1	Non-purposeful movements
	0	Not Moving
<b>Airway</b>	2	Coughing on command or crying
	1	Maintaining good airway
	0	Airway requires maintenance
<b>Vital Signs</b>	2	Stable and appropriate for age
	1	Stable but inappropriate for age
	0	Unstable
<b>Consciousness</b>	2	Awake
	1	Responding to stimuli
	0	Not responding
<b>Pulse Oximetry</b>	2	≥ 95% Saturation
	1	90-94% Saturation
	0	< 90%

At CNMC, discharge criteria include the following: appropriateness and stability of vital signs; absence of respiratory distress; ability to swallow oral fluids, cough, or demonstrate a gag reflex; ability to ambulate consistent with the developmental age level; absence of excessive nausea, vomiting, and dizziness; and a state of consciousness appropriate to the developmental level. Recent studies suggest that children should not be required to drink before discharge from the hospital.

Every child, regardless of age, must have an escort home. The escort is given written instructions concerning the child's home care and a telephone number to call to request further advice or to report complications. Staff counsels all parents about postoperative care; many units have also designed handouts that specify the care that should be provided and the signs that might herald a complication.

### **FURTHER READING**

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