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Patient selection criteria for paediatric ambulatory surgery

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The purpose of this paper is to summarize the major issues that must be considered in determining a child's eligibility for ambulatory surgery. Selection criteria for a child with a runny nose, heart murmur, asthma, bronchopulmonary dysplasia, congenital or acquired heart disease, and the ex-premature infant are discussed. Performing more complex procedures on sicker patients will be a continuing challenge for ambulatory surgery centres. The keys to success are careful patient selection and meticulous intraoperative and postoperative care.

Key words: Anaesthesia, outpatient, paediatric

During the 1980s, paediatric ambulatory surgery was limited to ASA physical status I or II patients undergoing brief surgical procedures. This is no longer true. The psychological, financial and medical benefits of minimizing the time spent in the hospital have all been cited as reasons to allow many more children, including those with significant underlying medical problems to undergo ambulatory surgery. More than 50% of all paediatric surgical procedures are now performed on an outpatient basis. As the number of ambulatory patients rises and their surgical care becomes more complex, it becomes increasingly important to have clear policies or guidelines on common problems such as fasting (NPO) times, patient selection, prophylaxis for subacute bacterial endocarditis and discharge criteria. The criteria for selecting patients for paediatric ambulatory surgery are especially important. Such guidelines vary between institutions and they are usually influenced by the condition of the patient, the attitude of the parents, the type of surgical procedure, and special considerations relating to anaesthetic management and recovery[1]. The purpose of this paper is to summarize the major issues that must be considered in determining a child's eligibility for ambulatory surgery.

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The patient: general considerations

Physical condition

The child should be in good health (ASA physical status I and II). If patients with moderately severe illness are accepted (ASA physical status III), their medical condition must be well controlled. Many children with chronic diseases benefit substantially from outpatient treatment. Immunocompromised patients benefit greatly from a limited hospital stay. Physically disabled, psychologically disturbed and mentally retarded children likewise benefit tremendously from the lack of separation and continued support of a parent or guardian that is usually fostered in outpatient facilities.

Although some centres require an anaesthetic preoperative visit, others have found that careful evaluation by the surgical staff, followed by telephone screening, is usually adequate[2]. Most problems requiring further evaluation are detected during the telephone interview and a special preoperative visit to the facility by the family may be arranged. Needs of specific groups of patients can then be detected and individual strategies developed to minimize difficulties. A special summary sheet, for example, may be completed by the oncologists for patients with cancer. The summary includes the names and dosages of chemotherapeutic agents, including steroids and adriamycin, and results of cardiac evaluation including echocardiographic findings, and ejection fraction. This summary is incorporated as part of the preoperative evaluation.

Age

Patients over a certain age (e.g. >80 years) are often considered inappropriate for ambulatory surgery. What about the other extreme? Is a three-day-old, full-term, otherwise healthy newborn infant an appropriate candidate for ambulatory surgery? Many ophthalmologists now prefer to perform surgery for congenital cataract on newborns as young as 2–3 days. The literature does not provide any conclusive data on which to formulate guidelines concerning the minimum acceptable age for ambulatory surgery. The first month of life is marked by rapid and profound physiological changes, such as closure of patent ductus arteriosus, decreased pulmonary vascular resistance, increased functional residual capacity, increased glomerular filtration rate, and physiological jaundice. At the Children's National Medical Center (CNMC), we have arbitrarily set the minimum age limit for ambulatory surgery for full-term infants at 2 weeks. By 2 weeks of age, the physiological jaundice would have abated, pulmonary vascular resistance decreased, and ductus arteriosus closed. We believe that ambulatory surgery is safer when these conditions have been resolved. Each centre, however, in consultation with neonatologists and surgeons, should set their own guidelines.

Sudden infant death syndrome (SIDS)

Full-term infants have a risk of developing SIDS during the first year of life. Although there is no evidence that anaesthesia or surgery increases the risk of SIDS[3], a recent case report by Tetzlaff et al.[4] which described a full-term infant, who developed two prolonged apnoeic spells in the postoperative period, raises concern. The cause of SIDS is not known and there is no diagnostic test available to identify SIDS-prone infants. Van der Hal et al.[5] noted that 62% of the infants with SIDS had an abnormal arousal response to hypoxia. Certain risk factors are, however, well established. If the patient has a sibling with the history of SIDS or if the mother has abused drugs during pregnancy, the risk of SIDS increases many fold. Infants whose history places them at high risk for SIDS should be closely observed during the postoperative period. It is also possible that a fatal apnoeic episode could coincidentally occur during the postoperative period, with no cause-and-effect relationship between anaesthesia and mortality.

The patient: special problems

The child with a runny nose

A child who presents for surgery 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. The runny nose, however, may signal an infectious process, in which case elective surgery should be postponed[6]. Since 20–30% of all children have a runny nose for a significant part of the year, every child with a runny nose must be evaluated on an individual basis.

The preanaesthetic assessment of these patiens consists of a complete history, a physical examination, and appropriate laboratory tests. Early in the clinical course of infection, the history is the single most important factor in the differential diagnosis. Information on allergies should be actively sought. Parents can usually tell whether their child's runny nose is a chronic condition – 'the usual runny nose' or something different. The physical examination is not always conclusive. Findings may be normal during the early part of an infectious process. Chronic allergic rhinitis, on the other hand, may be associated with local infections within the nasopharynx resulting in purulent nasal discharge. A white blood cell count >12 000–15 000 with a shift to the left suggests infection.

If surgery is postponed because of simple nasopharyngitis, it can usually be rescheduled in 1–2 weeks. If a 'flu-like syndrome that involves both the upper and lower respiratory tract is present, the surgery should be postponed until at least 1 month following resolution of symptoms.

A situation that often poses a dilemma is that of a child with a runny nose who presents for relatively brief or low-risk procedures such as the insertion of ventilation tubes for chronic serous otitis media. Many such children are scheduled several times for insertion of ear tubes but the procedures are cancelled because of a runny nose. Many anaesthesiologists are willing to proceed with this group of patients[6–8], and some have reported no increase in perioperative complications associated with uncomplicated upper respiratory infections (URIs)[7,8]. Because some of these children may be at increased risk of transient postoperative hypoxaemia, they should be given supplemental oxygen or have their oxygen saturation monitored during transport and in the postanaesthesia care unit (PACU)[9].

The ex-premature infant

The ex-premature infant may not be a suitable candidate for ambulatory surgery because of potential immaturity of the temperature control, respiratory centre and gag reflexes. Recent studies have reported perioperative complications such as apnoea in ex-premature infants who do not have a history of respiratory distress syndrome.

In a retrospective chart review of healthy infants undergoing herniorrhaphy, Steward[10] reported that 12% of preterm infants were observed to have prolonged apnoea up to 12 h after anaesthesia. Liu and coworkers[11] prospectively studied 214 infants including 41 former preterm infants. Eighteen infants, all of whom were less than 41 weeks' postconceptual age, had postoperative apnoea or required mechanical ventilation. None of the infants greater than 46 weeks' postconceptual age developed prolonged postoperative apnoea[11]. A large number of patients in this study required mechanical ventilation for other preexisting conditions (e.g. brain damage); consequently, the true incidence of apnoea that was pre-

cipitated solely by anaesthesia and surgery in this subgroup remains unknown.

In a study of 86 otherwise healthy infants of less than 12 months postnatal age undergoing general anaesthesia for herniorrhaphy, Welborn and coworkers[12] found no incidents of apnoea or periodic breathing with bradycardia on postoperative pneumograms. Some infants in this group had a history of preanaesthetic apnoea and were being monitored for apnoea at home[12]. Periodic breathing without bradycardia, however, was noted in 14 of 38 preterm infants during the postoperative period. Periodic breathing occurred as late as 5 h postoperatively. The lower the infant's gestational age, the more frequent the incidence of periodic breathing. Neither apnoea nor periodic breathing occurred in former premature infants whose conceptual age was more than 44 weeks and who had no major systemic disease at the time of surgery. In a later study, however, Welborn[13] reported a 73% incidence of postoperative prolonged apnoea with bradycardia in a similar group of infants whose conceptual ages ranged between 35 and 44 weeks. In still another prospective study using pneumography, Kurth and coworkers[14] reported a 37% incidence of prolonged postanaesthetic apnoea in 47 former preterm infants whose conceptual ages varied from 32–55 weeks. The initial episode of apnoea occurred as late as 12 h after anaesthesia.

Although the total cases reported in the literature to date is approximately 300, no single study has included a large number of ASA physical status I or II patients undergoing the same operative procedures with the same anaesthetic technique. Many of the data are derived from retrospective reviews of complications or from patients with preexisting disease who underwent complex surgical procedures. Therefore, it is difficult to formulate definitive guidelines for ambulatory surgery in the formerly premature infant. Further complicating the issue is a lack of understanding of the clinical significance of apnoeic episodes that result in bradycardia and arterial oxygen desaturation but eventually self-correct before cardiorespiratory arrest develops. While the spontaneous return of respiration is probable in these infants, it is possible that the apnoeic episodes may have hypoxic effects on the brain. Even a relationship to SIDS has been suggested. Failure to detect and treat breathing irregularities in these high-risk infants may increase the likelihood of sudden death. In brief, the anaesthesiologist must be aware that a history of prematurity is a 'red flag'; such infants must be observed carefully for episodes of postoperative apnoea.

The age at which the premature infant attains physiological maturity and no longer presents an increased risk must be determined individually. It appears that as the child matures, the tendency toward apnoea greatly diminishes, but no one knows the age when all babies may be safely anaesthetized on an outpatient basis. Factors that govern the decision include the infant's growth and development, problems during feeding, time to recovery from upper respiratory infections, and a history of apnoea or metabolic, endocrine, neurological or cardiac disorders.

The infants at greatest risk are those younger than 46 weeks post-conceptual age who have a history of apnoea. Beyond this, one must establish a middle ground between the conservative 60 weeks recommended by Kurth and coworkers[14] and the recommendations of Liu et al.[11] and Welborn et al.[12] who believe that ambulatory surgery may be safely performed at 44–46 weeks. Until more extensive, meticulous, prospective studies are carried out, it seems prudent to admit to the hospital all ex-premature infants scheduled for surgery at less than 50 weeks postconceptual age and to monitor them for postoperative apnoea, bradycardia, and oxygen desaturation. If the infant has bronchopulmonary dysplasia (BPD), this period should be extended for as long as the infant is symptomatic. It is also appropriate to individualize all decisions and, when in doubt, to err on the conservative side. Should any questions arise, inpatient care is recommended.

Recent reports by Welborn and coworkers[13,15] suggest that a single intravenous dose of caffeine at the beginning of surgery may control postanaesthetic apnoea in former premature infants. When a 5 mg kg^{-1} dose was used, no infant developed prolonged apnoea with bradycardia; some infants, however, developed periodic breathing[13]. A 10 mg kg^{-1} dose of caffeine, by contrast, controlled all types of apnoea in these infants[15]. Until more extensive experience with this approach is available, all infants at risk should be monitored for apnoea and/or bradycardia following anaesthesia.

Bronchopulmonary dysplasia (BPD)

The infant with BPD presents several problems, including decreased pulmonary function with airway hyperreactivity, residual lung disease which may cause hypoxia and hypercarbia; and an abnormal response to hypoxia, which may lead to apnoea, hypoxia, bradycardia, and sometimes death[16]. Decisions regarding patients' suitability for ambulatory surgery must be made on an individual basis. Patients with persistent wheezing, hypercarbia, and oxygen dependency are generally unsuitable for ambulatory surgery. They should be admitted to the hospital for preoperative treatment that will optimize their physical condition. Cardiorespiratory monitoring is often required following surgery.

The child with a heart murmur

The incidence of heart murmurs in children over one month of age is greater than 50%. The murmur is often first heard during the preanaesthetic examination. Even if the child is asymptomatic, it is imperative that the cause of the murmur be diagnosed prior to anaesthesia and surgery. Newburger et al.[17] have concluded that a paediatric cardiologist can reliably confirm an innocent murmur by physical examination alone[17]; whether other physicians including paediatricians can consistently diagnose an organic murmur is debatable. At CNMC, the grid shown in Table 1 serves as a guide to determine the need for a cardiology consultation[1].

Table 1. The child with a heart murmur

Clinical diagnosis By whom?	*No heart disease*	*Possible heart disease*		*Definite heart disease*
Anaesthesiologist	Yes	Yes	No	Yes
Paediatrician	Yes	No	Yes	Yes
Cardiology consult?	No	Yes	Yes	Yes

A child with a murmur may not require specific preoperative cardiac therapy or even a modification in the selection of anaesthetic agents and technique. Such a child does, however, usually need antibiotic prophylaxis to prevent subacute bacterial endocarditis (SBE). For quick reference, every department of anaesthesiology should have available the most recent American Heart Association's guidelines for prevention of bacterial endocarditis[18]. Children who have innocent heart murmurs do not require SBE prophylaxis. Prophylaxis is also not required for orotracheal intubation and myringotomy. It is generally safe to proceed with surgery if the child has a normal growth and activity pattern, and the murmur is characterized as of low intensity, nonradiating, and early systolic. When in doubt, it is best to consult a cardiologist.

Congenial or acquired heart disease

Congenital heart disease occurs in 0.08% of newborn infants. The decision to schedule such a child for ambulatory surgery must be made only after communication with the cardiologist and surgeon. If the cardiac status is stable and a cardiologist has been following the child, ambulatory surgery may be appropriate. Response to four questions should determine the anaesthetic plan[19].

1. Is there a cardiac shunt (e.g. ventricular septal defect)?
2. Is there obstruction to blood flow (e.g. valvular stenosis, coarctation)?
3. What are the consequences of the defect (e.g. congestive heart failure, cyanosis)? and
4. What is the relationship of pulmonary vascular resistance and systemic vascular resistance?

If there is a cardiac shunt, meticulous attention should be paid to eliminating air bubbles from the intravenous lines, and to maintain a left to right shunt flow. Patients with congestive heart failure must continue to receive all medications until the morning of surgery. If the child is cyanotic due to decreased blood flow to lungs secondary to increased pulmonary vascular resistance, hyperventilation and high FiO_2 will improve blood flow to the lungs. If pulmonary flow is increased, then ventilation with positive end-expiratory pressure and reducing inspired oxygen concentration will decrease pulmonary blood flow.

If there is any question about the stability of cardiac lesion, hospital admission is advised. Patients requiring routine supplemental oxygen should be hospitalized.

Asthma

Asthma is the most common major disease among children. The prevalence of asthma among children in the United States is 7.6%. Most patients have their first attack before their third birthday[20]. The prevalence of asthma is rising, as are hospitalization and mortality rates associated with this condition. Asthma is one of the four most common problems identified during preoperative telephone screening for paediatric ambulatory surgery[2]. The severity of asthma varies greatly in children. Some patients have infrequent attacks, often associated with a cold or with the allergy season. They require minimal medication, and their wheezing is easily controlled by an inhaler or theophylline. Such patients are appropriate candidates for ambulatory surgery. The second group has moderately severe asthma and require continuous therapy. It is important to know their baseline status and communicate directly with their primary physician before scheduling them for ambulatory surgery. Should ambulatory surgery be scheduled, these children must receive their medications until the morning of surgery. A β agonist should be administered in the operating room holding area. If the patient has persistent cough, wheezing, or tachypnoea on the day of surgery, it is best to reschedule surgery. Some children with severe asthma are never completely free of wheezing. If surgery is needed, they usually require admission to the hospital.

Malignant hyperthermia

Many children are presumed to be malignant hyperthermia susceptible (MHS) because of a family history suggestive of MH or a previous suspected MH reaction. Few patients actually have biopsy proven MHS. Children otherwise suitable for ambulatory surgery are often hospitalized overnight solely because they are known or suspected to be MHS. Yentis et al.[21] concluded from their retrospective anaysis that postoperative admission to the hospital solely on the basis of the MHS label is not warranted. Intraoperative use of nontriggering agents and 4 h of postoperative observation are, however, recommended.

Preoperative laboratory testing

Healthy children who are scheduled to undergo surgical procedures that are not associated with the possibility of extensive blood loss require only minimal preoperative laboratory testing. In some instances, such testing is governed by hospital or state policy. Roy et al.[22] studied

2000 patients, aged between 1 month and 18 years, who were scheduled for minor surgery. The incidence of anaemia was 0.5%; approximately 75% of these children underwent anaesthesia without complications. The authors concluded that healthy children, 5 years and older, scheduled for minor surgery do not require routine haemoglobin determination. Hackman et al.[23] prospectively studied the prevalence of anaemia in paediatric day-surgery patients and evaluated the anaesthesiologists' ability to detect preoperative anaemia clinically. Of the 2649 patients, 14 (0.5%) were anaemic. Seven of the anaemic patients were less than 1 year of age. Only five patients were predicted to be anaemic based on clinical examination. The authors concluded that a mild degree of anaemia does not alter the decision to proceed with the ambulatory surgery and that anaesthesiologists cannot reliably detect anaemia clinically.

It has been proposed that routine preoperative haemoglobin testing is necessary only for: (a) children less than 1 year of age; (b) children who have never been tested for sickle cell disease; and (c) children with systemic disease. Most anaesthesiologists now accept haematocrits in the mid-20s for elective surgical procedures, provided there are no other systemic problems.

Pregnancy testing

Testing adolescents for pregnancy is another controversial issue in paediatric ambulatory surgery. The rate of teenage pregnancy is increasing not only in urban populations but also in suburban and rural areas. Some hospitals perform pregnancy tests routinely on every female patient over the age of 12 years; however, most centres first screen patients by obtaining a good history. Accurate history is most often obtained by female personnel, such as the nursing staff in the admission area. Questions about the girl's last menstrual period should be asked in confidence in a private area. A pregnancy test should be ordered if the history suggests that there is a chance of pregnancy.

Preparing the parents

In the past, the choice of outpatient vs. inpatient care was largely influenced by parents' wishes and the experiences of friends and family. Third-party payors and government regulators are now increasingly reluctant to comply with parents' demands for hospitalization of a healthy child who is scheduled to undergo a minor operation. Parents of children who are scheduled for paediatric outpatient surgery, however, should be capable of understanding and be willing to follow specific instructions related to ambulatory surgery. In most cases, it is up to the physician to educate parents and make them feel secure and comfortable.

The surgical procedure

The surgical procedure should only be associated with minimal to moderate bleeding and physiological derangements. Most 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 five most frequently performed operations at the Children's National Medical Center day surgery unit during the past 2 years were herniorrhaphy, myringotomy, adenoidectomy with or without myringotomy, circumcision, and eye-muscle surgery.

Because of the risk of haemorrhage, there is a debate as to the advisability of performing tonsillectomy as an outpatient procedure. In 1968, Chiang and associates[24] reported performing 40 000 outpatient tonsillectomies and adenoidectomies (T&A) without death. To decrease the risk of haemorrhage, they emphasized that patients must be carefully selected. The preoperative evaluation should seek to eliminate patients with bleeding tendencies and cardiopulmonary disease. As further safeguards, no 'allergic' patient was operated on during the pollen season, and no operation was performed until 4–5 weeks after an acute attack of tonsillitis. More recently, Maniglia and coworkers[25] reported a series of 1428 adenotonsillectomies performed on outpatients. There were two cases (0.14%) of immediate bleeding (within 24 hours) and two of secondary bleeding (after 24 hours). The two incidents of immediate bleeding occurred within the first hour following the surgical procedure. Secondary haemorrhage occurred 1 week after surgery. The authors concluded that outpatient adenotonsillectomy is safe and cost effective, and that there was little benefit in keeping patients in the hospital more than a few hours after surgery.

Recently, there have been reports of postoperative apnoea and/or obstruction in children following tonsillectomy[26]. Many of these patients are young (< 3 years) and have a documented history of preoperative sleep apnoea or other obstructive phenomena during sleep. In extreme cases the airway obstruction can result in pulmonary hypertension and cor pulmonale[27]. It is therefore important that the indication for tonsillectomy (repeated infections vs. obstructive symptoms) be carefully reviewed, especially in young patients. Postoperative cardio-respiratory monitoring or even ICU admission for airway support may be necessary in the latter group.

Conclusion

Growing experience in the past decade has proved that ambulatory surgery is both safe and cost effective. The number of patients undergoing ambulatory surgery has risen to over 50%[28]. Although the growth rate is not likely to be as exponential as the 1980s in the coming years, payors will continue to exert pressure to do more procedures on an ambulatory basis[28]. Performing more complex procedures on sicker patients will be a continuing challenge for ambulatory surgery centres. The keys to success are careful patient selection and meticulous intraoperative and postoperative care.

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