Challenges in Pediatric Ambulatory Anesthesia

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THE UPPER RESPIRATORY TRACT INFECTION DILEMMA

Most anesthesiologists agree that the presence of an acute purulent upper respiratory tract infection (URI), fever, or any symptomatology of a lower respiratory infection would be sufficient grounds to postpone an elective surgical procedure. However, the child with a nonpurulent active or recent URI (within 4 wk) nearly always presents a conundrum even for the most experienced anesthesiologists.

It has been documented that 20%–30% of all children have a runny nose a significant part of the year. In the preanesthetic evaluation, we must rely on history, physical, and occasionally laboratory data to decide whether to proceed with the anesthetic. A differential diagnosis of a child with a runny nose is seen in Table 1.

Previous studies have shown that children with a URI, particularly those <1 yr of age, have an increased risk of respiratory related adverse events intraoperatively and postoperatively (1,2). Also, symptomatic infants with a URI have decreased time to desaturation during apnea (2). Endotracheal intubation (ETT) has been shown to be a major risk factor for hypoxemia, bronchospasm, and atelectasis in children with a URI (1–3). Temporary airway hyperactivity is known to exist for 6 wk after a viral infection (4).

Schreiner found that URI is a predictor of increased risk of laryngospasm (5), whereas according to Tait and Knight, it was not (6,7). Risk of laryngospasm has been found to be 10-fold higher in children exposed to tobacco smoke (8). Comparison of ETT with laryngeal mask airway (LMA) use in children with a URI showed a significantly lower incidence of mild bronchospasm, major desaturation events (oxygen saturation <90%), and overall respiratory events with LMA use (9). The incidence of laryngospasm was equal.

Most of us agree children who are obviously ill and scheduled to undergo elective surgery should have their surgeries postponed until they are better if only for humane reasons i.e., so they do not have the double effects of a systemic illness, coughing, and the pain of the surgical incision. But, what about children with mild URIs for whom both parents have taken the day off work to be with the child for the surgical procedure?

One recent study looked at 2051 children of which 22.3% had symptoms of URI on the day of surgery, 45.8% had a "cold" in the preceding 6 wk, and 30% were asymptomatic controls (10). Forty of the 2051 children did not proceed to anesthesia and surgery on the basis of the preanesthetic consult. The nonanesthetized children were more likely to have runny nose, cough, wheezing, malaise and fever and were said to have a cold by the parents. There is some bias in this study first because the policy in this hospital is to reschedule elective cases with a URI if they are younger than 12 mo of age and require intubation, and the second bias is the use of anesthesiologists to record adverse events occurring during anesthesia rather than an independent observer who was blinded to the patients perioperative condition.

Significant patient predictors were parental confirmation of the child's URI symptoms, presence of nasal secretions, history of snoring, passive smoke exposure, and sputum production. As far as anesthetic risk factors, choice of airway management was identified as an independent risk factor for postoperative adverse events; specifically, the risk was higher with ETT than with LMA or face mask respectively.

Thiopental for induction was associated with the highest probability of an adverse event followed by halothane and sevoflurane with propofol having the lowest probability. Propofol depresses laryngeal reflexes and may decrease airway responsiveness by relaxation of bronchial smooth muscle (11,12). The administration of neostigmine was the final predictor. Children who had muscle relaxants reversed had a lower probability of an adverse event than those who did not. Residual neuromuscular blockade may have subtle effects on outcomes and atropine administration with neostigmine may have the beneficial effect of decreasing secretions.

In conclusion, this study suggests children whose parents say they have a cold, who are snorers, passive smokers, have nasal congestion or a productive cough have a higher risk of anesthetic complications. Intubation increases the risk of complications and with LMA or face mask use the probability is decreased. Propofol is the safest induction agent and muscle relaxants should always be reversed. It is prudent to cancel nonurgent surgery if the patient wheezes, is febrile, is suffering malaise, or if the child is very young (<1 yr of age).

In a prospective study with 1078 patients comprising roughly equal thirds having active URI symptoms, recent URI symptoms within the previous 4 wk, or no URI symptoms, respiratory adverse events were most

Table 1. Differential Diagnosis of a Child with a Runny Nose

Noninfectious causes
Allergic Rhinitis: Seasonal, perennial
Vasomotor Rhinitis: Emotional (crying), temperature
Infectious Causes
Viral infections
Nasopharyngitis (common cold)
Flu syndrome (upper and lower respiratory tract)
Laryngotracheal bronchitis (infectious croup)
Viral exanthems
Measles
Chicken pox
Acute bacterial infections
Acute epiglottitis
Meningitis
Streptococcal tonsillitis

prevalent in the active URI group (13). There was also a significantly higher incidence of desaturation in both the active (15.7%) and recent (14.7%) URI groups versus the non-URI group. There was no statistically significant difference in the incidence of bronchospasm or laryngospasm between groups. In this study, only nine of 407 patients (2.2%) with an active URI confirmed by the parent required succinylcholine for management of laryngospasm, and only three children—one with a recent URI and two with active URIs—required unanticipated admission to hospital.

By employing logistic regression (13), in 1078 children with active, recent or no URI symptoms, patient risk factors associated with adverse outcomes included copious secretions ($P = 0.0001$), ex-premature infants ($P = 0.007$), nasal congestion ($P = 0.014$), parental smoking ($P = 0.018$), and reactive airway disease ($P = 0.028$). ASA status did not correlate with adverse outcomes.

The specific role age plays in the presence of URI has not been elaborated in all studies, but this study (13) showed that infants <6 mo old with active URIs had a higher incidence of bronchospasm (20.8% vs 4.7%, $P = 0.08$) than older children. This same study also showed that children younger than 2 yr of age had a higher incidence of oxygen desaturation than older children (21.5% vs 12.5%, $P = 0.023$).

Anesthetic risk factors identified ETT in children younger than 5 yr of age as an independent risk factor for postoperative respiratory adverse events ($P = 0.0002$) (13). Of note, duration of anesthesia and awake versus deep extubation were not identified as risk factors. Children with active URIs had the lowest incidence of problems when induced and maintained with sevoflurane. There was a high incidence of adverse respiratory events in children undergoing airway surgery, e.g., tonsillectomy and adenoidectomy, direct laryngoscopy, and bronchoscopy in all three groups.

The conclusions of this study were children with active and recent URIs (within 4 wk) are at increased risk for adverse respiratory events particularly if they have a history of reactive airway disease, require surgery involving the airway, have a history of prematurity, are exposed to environmental tobacco smoke, have nasal congestion or copious secretions or require placement of an endotracheal tube.

In afebrile ASA I or II children having either a URI within 6 wk or an active URI disease undergoing noncavitary nonairway surgery for <3 h, pretreatment with bronchodilators before anesthesia (either inhaled ipratropium or albuterol) showed no decrease in adverse airway events (14).

There is risk to anesthesia even in children without URIs. The child with a URI has an increased risk for laryngospasm, bronchospasm, desaturation, and postintubation group, especially if someone in the home smokes. Not all children with a URI should be anesthetized, but careful consideration should be given to severity of presenting symptoms, patient's respiratory history, need for endotracheal intubation, choice of anesthetic agent, and the anesthesiologist's overall comfort with anesthetizing children with URIs.

We must wait 4–6 wk or longer to decrease these risks. We can tailor our anesthetic to decrease these risks (propofol, LMA or face mask instead of ETT), but they cannot be reduced to zero. Good judgment, common sense, clinical experience, and informed consent of parents must be used when deciding whether to cancel or proceed and discussions should be documented in the chart. The algorithm given (Fig. 1) may be helpful in decision making.

THE CHILD WITH SLEEP APNEA FOR ADENOTONSILLECTOMY

Sleep apnea is a sleep-related breathing disorder in children characterized by a periodic cessation of air exchange, with apnea episodes lasting >10 s and an apnea/hypopnea index (AHI, total number of obstructive episodes per hour of sleep) >5. (15) Air flow cessation is confirmed by auscultation or oxygen desaturation <92%. Types of sleep apnea include central (absent gas flow, lack of respiratory effort), obstructive (absent gas flow, upper airway obstruction, and paradoxical movement of rib cage and abdominal muscles) and mixed (due to both CNS defect and obstructive problems). Diagnosis is made by clinical assessment (a history of snoring and restless sleep), nocturnal pulse oximetry, or polysomnography studies (PSG).

Obstructive sleep apnea syndrome (OSAS) is manifest by episodes that disturb sleep and ventilation. These episodes occur more frequently during REM sleep and increase in frequency as more time is spent in REM sleep periods as the night progresses. OSAS occurs in children of all ages (about 2% of all children) but more commonly in children 3–7 yr of age. It occurs equally among boys and girls, but the prevalence may be higher in African American individuals (16). Signs of OSAS as sleep disturbances include daytime sleepiness, failure to thrive from poor intake due to tonsillar

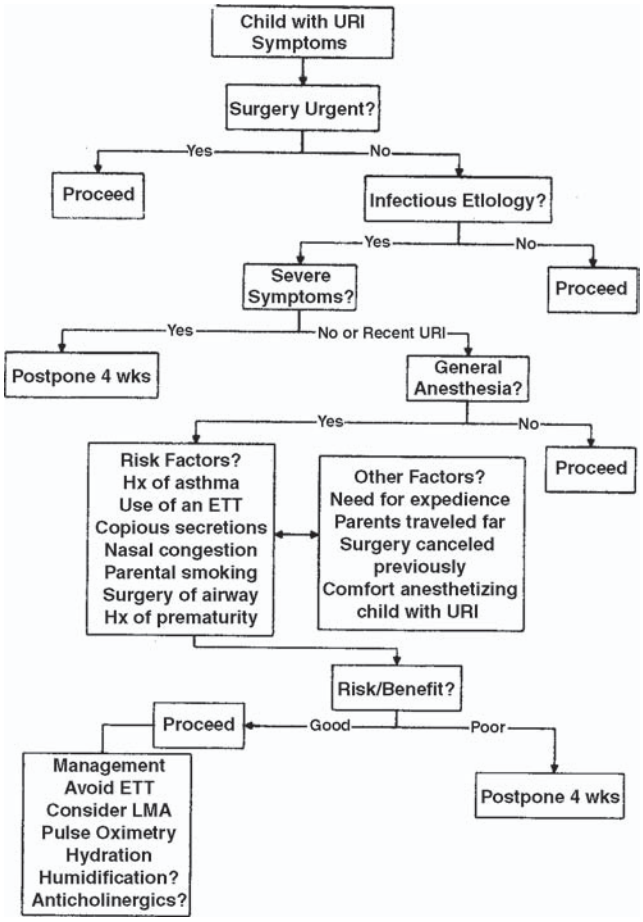

Figure 1. Suggested algorithm for the assessment and anesthetic management of the child with an upper respiratory infection. URI = upper respiratory infection; Hx = history; ETT = endotracheal tube; LMA = laryngeal mask airway. (From Tait AR, Malviya S. Anesth Analg 2005;100:59–65).

hypertrophy, speech disorders, and decreased size (decreased growth hormone release during disturbed REM sleep). This syndrome can cause significant cardiac, pulmonary, and CNS impairment due to chronic oxygen desaturation. Pulmonary vasoconstriction can increase pulmonary vascular resistance with resultant decrease in cardiac output due to cor pulmonale. Relief of the tonsillar/adenoidal obstruction can reverse many of these problems and prevent progression of others (pulmonary hypertension and cor pulmonale).

The American Academy of Pediatrics Clinical Practice Guidelines (16) give the following recommendations for inpatient monitoring in patients at high risk for postoperative complications that have OSAS and are undergoing adenotonsillectomy. These include

Age younger than 3 yr
Severe OSAS on polysomnography
Cardiac complications of OSAS (e.g., right ventricular hypertrophy)
Failure to thrive
Obesity
Prematurity
Recent respiratory infection
Craniofacial disorders
Neuromuscular disorders
Cerebral palsy
Down syndrome
Sickle cell disease
Central hypoventilation syndromes
Genetic/metabolic/storage disease
Chronic lung disease

As far as outpatient surgery for adenotonsillectomy in patients with OSAS, children age 1–18 yr without underlying medical conditions, neuromuscular disease, or craniofacial abnormalities with mild sleep apnea (<15 obstructive events per hour) will have improvement of their airway obstruction documented by polysomnography the night of surgery and do not need to be monitored intensively. In these patients the number of obstructive events and fewer severe oxygen desaturations occurred on the operative night (17). Based on this and other studies it is possible to consider discharge to home for children age 3–12 yr if they meet these criteria.

However, patients with preoperative nocturnal oximetry with an oxygen saturation of 80% or less had an increase from 20% to 50% in postoperative respiratory complications. Frequently these children were younger (<2 yr) and had an associated medical condition (18). Sixty percent of OSAS patients requiring urgent adenotonsillectomy had postoperative respiratory complications. Risk factors for respiratory complications were again an associated medical condition and preoperative nocturnal oxygen saturation nadir <80%. Atropine administration at induction decreased the risk of postoperative respiratory complications. There was an 11.1% incidence of reintubation and a 9.3% incidence of postoperative pneumonia in this urgent adenotonsillectomy group (19).

Children with severe OSAS who had adenotonsillectomy in the morning were less likely to have postoperative desaturation than those who were operated in the afternoon (20). The shortened time interval between postoperative morphine dosing and bedtime may contribute to the incidence of postoperative desaturation because of an exaggerated respiratory depressive response to opioids which has been reported in children with severe OSAS (21). There is a strong possibility that the combination of opioids and sleep promote desaturation in these patients.

Children with OSAS in general may have a diminished ventilatory response to CO_2 rebreathing compared with normal children (22). Therefore, drugs known to cause ventilatory depression (sedative hypnotics, anxiolytics, narcotics and inhaled agents) must be used judiciously in these patients as they may be more sensitive to their effects. Younger aged patients or those with preoperative nocturnal oxygen saturation <85% had reduced morphine requirement possibly due to up-regulation of central opioid receptors consequent to recurrent hypoxemia (23). Children

whose minimum nocturnal desaturation was <85% required one half of the dose of opioids for similar pain scores after adenotonsillectomy surgery compared with children whose minimal saturation was 85% or greater (24). Drugs for pain management to decrease opioid use include ketamine 0.1 mg/kg (25) and dexamethasone 0.5–1 mg/kg (maximum 25 mg) (26,27). In addition, a new surgical technique partial intracapsular tonsillectomy for children with OSAS results in less postoperative pain and opioid use.

Although the respiratory distress index improves in children with severe sleep apnea and in obese children with OSAS after adenotonsillectomy, the OSAS may not resolve in the majority of these children and some may need a postoperative PSG and additional therapy such as uvulopalatoplasty (UPPP) or tracheostomy (28). It is important to realize that these children may have increased anesthetic risk if they return for other surgeries.

WHAT IS THE YOUNGEST AGE APPROPRIATE FOR OUTPATIENT SURGERY?

Outpatient surgery accounts for a significant percentage of anesthetics delivered in the United States and may be appropriate in infants for certain procedures. The most concerning adverse event after general anesthesia in an infant is postoperative apnea.

Apnea Risk

There is little specific evidence of the risk of apnea in full term infants. There are facilities that feel comfortable performing outpatient surgeries if the infant is born at greater than 37 wk postconceptual age. However, other ambulatory centers prefer to wait until the infant is 2–4 wk of age to ensure decreased physiologic jaundice, decreased pulmonary vascular resistance and to give time for the ductus arteriosus to close. As far as sudden infant death syndrome (SIDS) there is no evidence anesthesia increases the risk (29). However, if the patient has a sibling with a history of SIDS or if the mother has abused drugs in her pregnancy the risk increases many fold. The infants whose histories suggest a high risk for SIDS should be monitored closely for a longer perioperative period.

In the premature infant, apnea is more likely to occur as well as other airway complications such as atelectasis, aspiration pneumonia, stridor, and coughing with desaturation in infants undergoing inguinal herniorrhaphy (30). The best evidence based data is found in Cote's (31) combined analysis of 255 preterm infants undergoing inguinal herniorrhaphy under general anesthesia. Apnea was defined as >15 s without bradycardia or <15 s when accompanied by bradycardia. Apnea was strongly and inversely related to both gestational age and postconceptual age and to continuing apnea at home and anemia (<10 gm/dL). In the nonanemic child with a gestational age of 32 wk and a postconceptual age of 56 wk, the probability of apnea was <1%. With a gestational age of 35 wk, a postconceptual age of 54 wk was the cutoff for apnea to be present in <1% of patients.

Caffeine has been shown to decrease the risk of apnea in preterm infants undergoing general anesthesia. In 32 preterm infants (37–44 wk postconceptual age) who received caffeine 10 mg/kg or placebo, the caffeine group had no postoperative bradycardia, prolonged apnea, periodic breathing or postoperative oxygen saturation <90%, whereas 81% of the patients in the control group had prolonged apnea at 4–6 h postoperatively (32). A systematic review supported the evidence that caffeine reduces apnea risk (33).

Anesthetic Technique

Spinal anesthesia alone has been shown to have a lower incidence of postoperative apnea and bradycardia in former premature infants when compared to spinal plus sedation or general anesthesia (34). Also a decreased incidence of oxygen desaturation and bradycardia has been seen (35). Central apnea was not reduced, so obstructive apnea may play a role with sedation or general anesthesia (36). Spinal anesthesia may be indicated in high risk infants. Still the chance for cardiopulmonary events are increased in these infants, and the same postoperative monitoring as for general anesthesia is indicated (37,38).

Patients <60 wk postconceptual age for hernia repair had shorter times to extubation with no postoperative apnea after thiopental or halothane induction with desflurane maintenance than either halothane or sevoflurane for the entire anesthetic (39). Avoidance of opioids where possible and the use of regional anesthetic techniques and nonopioid systemic analgesics such as acetaminophen and nonsteroidal antiinflammatory agents may decrease the risk of apnea.

Recommendations

The cutoff for outpatient surgery in infants born before 37 wk may be 50–52 wk postconceptual age as long as there is no anemia, prior apnea or coexisting disease. However, looking at the evidence based literature to decrease the risk of apnea to <1% patients should be greater than 54 wk postconceptual age without anemia, ongoing apnea or other significant medical problems. Postoperative monitoring ranges from 12–24 h, including oxygen saturation, heart rate, and impedance pneumography and whether the infants are apnea-free before discharge.

Caffeine or spinal anesthesia may decrease the risk of apnea, but patients should not be discharged if they are not eligible for anesthesia on an outpatient basis. Full-term infants are acceptable for outpatient procedures provided that they are otherwise healthy and the procedure is not likely to result in significant physiologic changes or postoperative pain requiring opioid medication and the anesthetic is uneventful. Even in term infants some facilities will not allow

outpatient surgery until they are of 44–46 wk postconceptual age or require longer observation if younger, e.g., 4 h.

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