Current Trends in Pediatric Anesthesia

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Abstract

New trends in pediatric anesthesia for ambulatory surgery will be described. Preoperative preparation as well as care of pediatric patients requiring sedation outside of the operating room are emphasized.
Key Words: Pediatric anesthesia, sedation.

Pediatric Anesthesia for Ambulatory Surgery

MOST ELECTIVE PEDIATRIC SURGICAL PROCEDURES are performed on an outpatient basis. The ideal anesthesia for pediatric ambulatory surgery promotes rapid recovery, provides adequate postoperative analgesia, and avoids postoperative nausea and vomiting.

While total intravenous anesthesia (TIVA) has become popular for adult outpatient anesthesia, it is not frequently utilized with pediatric patients, because of the difficulty in establishing intravenous access in children who are awake. However, the discomfort of intravenous line placement may be minimized by the use of EMLA cream (eutectic mixture of 2.5% lidocaine and 2.5% prilocaine) applied 45 minutes prior to venipuncture. EMLA cream also reduces the pain of other procedures involving needlesticks, such as lumbar punctures or the repair of minor lacerations. Because of their synergistic effect, a combination of a sedative/hypnotic agent with an opioid provides a smooth anesthetic and reduces the individual agent's total dose. Propofol is ideally suited for TIVA, because of its rapid onset and termination of effect. Because of their larger volume of distribution and faster clearance, pediatric patients require higher bolus and infusion doses/body weight compared to adults (1). Propofol reduces the incidence of nausea and vomiting, particular after emetogenic procedures such as otological or ophthalmological surgery. In addition, emergence delirium is uncommon after propofol (2).

The new, ultra-short-acting narcotic, remifentanil, has been used in pediatric anesthesia (3). The blood-brain equilibration is prompt, accounting for its rapid onset. Since it is rapidly hydrolyzed by plasma esterases to inactive metabolites, its duration of action is not influenced by hepatic or renal clearance. Its context-sensitive half-time, the time required for a 50% decrease in plasma concentration following an infusion regimen designed to maintain a constant plasma concentration for a specific period of time, is approximately 3 minutes irrespective of dosing and duration of infusion (4).

Since the primary narcotic effect of remifentanil ends so quickly, other modalities of postoperative pain relief must be utilized. Postoperative analgesia can be provided by a number of drugs, including acetaminophen, a potent non-steroidal anti-inflammatory agent such as ketorolac, a longer-acting narcotic such as fentanyl or morphine-sulfate, or supplemental local and regional nerve blocks. Acetaminophen is effective for postoperative pain relief, but it must be given in adequate doses (e.g., 40 mg/kg rectally) (5). Nerve blocks are particularly useful after orthopedic and surgical procedures below the umbilicus or on an extremity. Caudal and epidural techniques, as well as inguinal, penile, axillary, and femoral nerve blocks, have been used successfully in pediatric patients. Preemptive local and regional anesthesia leads to smoother emergence; the incidence of nausea and vomiting is decreased, since narcotics are avoided (6).

Because of its ease of administration, inhalation anesthesia is still the technique most widely practiced for pediatric patients. The

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minimum alveolar concentration (MAC) of the anesthetic that prevents movement as a response to skin incision in 50% of patients increases after the first month of life, peaks at approximately 6 months and progressively declines throughout childhood until adulthood. Depth of anesthesia can easily be controlled by changing inspired concentration and manipulating minute-ventilation and/or total fresh gas flow. Inhalation anesthetics are cleared rapidly; this rapid recovery may lead to emergence delirium, particularly if pain relief is inadequate (7, 8). Sevoflurane is the most widely used new volatile anesthetic for children. Because of its low blood-gas solubility as well as the high minute-ventilation to functional residual capacity (FRC) ratio in children, sevoflurane has a rapid onset of action. Sevoflurane has a low incidence of airway irritability and minimal cardiovascular side effects. In contrast, desflurane leads to an unacceptable incidence of airway complications when used to induce anesthesia.

NPO Guidelines and Preoperative Laboratory Assessment

One of the most unpleasant aspects of preoperative preparation for parents and children has been the required blood tests and the directives regarding feeding and fluid intake. Changes in these have recently been introduced.

Measurement of hematocrit is particularly important for infants less than 6 months old, since there is a high incidence of unrecognized anemia, which may be a risk factor for perioperative apnea and cardiac arrest (9). Patients over the age of 6 months with no pre-existing medical disease (such as sickle-cell anemia, diabetes, renal or hepatic failure) require no preoperative laboratory studies (10).

Reducing the time of preoperative fasting diminishes the extent of dehydration and possibility of hypotension on induction of anesthesia (11). This must be balanced against the risk of aspiration of gastric contents in the perioperative period. However, numerous studies have failed to document an increased risk of perioperative aspiration in healthy patients when fasting guidelines were relaxed (12, 13). For this reason, the American Society of Anesthesiologists (ASA) adopted new guidelines on perioperative fasting in October 1998 (14). These guidelines allow for the intake of clear liquids until 2 hours before the planned procedure, breast-milk until 4 hours before the planned procedure, and infant formula, milk or a light meal until 6 hours before the procedure. With these guidelines, there is less stress on parents to keep a toddler happy during the preoperative period.

Sedation outside the OR

Minor surgical procedures performed outside the operating room, invasive diagnostic or therapeutic procedures, and non-invasive diagnostic studies requiring the patient to remain immobile for extended periods of time require sedation for a majority of pediatric patients. Although anesthesiologists are providing this service more frequently, there are not enough anesthesiologists for all patients. Many insurance carriers are unwilling to reimburse physicians for these services. To safeguard pediatric patients, the American Academy of Pediatrics first issued guidelines for the elective use of conscious sedation, deep sedation, and general anesthesia in 1985; these guidelines were updated in 1992 (15). In 1996, the American Society of Anesthesiologists issued "Practice Guidelines for Sedation and Analgesia by Non-anesthesiologists" (16). The American College of Radiology (17) and the American College of Emergency Room Physicians (18) have also issued guidelines for sedation, as have various other subspecialty groups like critical care, cardiology, gastroenterology and endoscopy. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has appointed the anesthesia department as the watchdog in every institution to assure that sedation is performed appropriately and safely (19). The JCAHO defines conscious sedation as "a state that allows patients to tolerate unpleasant procedures while maintaining adequate cardiorespiratory function and the ability to respond purposefully to verbal commands." Unfortunately, in pediatric patients, conscious sedation is rarely achievable. Patients must be sedated and monitored by appropriately trained individuals, and back-up systems must be available to quickly manage any complication. The JCAHO standards dictate that standards that are applicable to the administration of general anesthesia are also applicable to children undergoing sedation (19).

The institutional performance-improvement system approves physicians and sedation protocols and monitors compliance and complications (20). In a prospective review of 1140 cases of pediatric sedation by non-anesthesiologists, the sedation failure rate was 13.2% and oxygen desaturation occurred in 5.5% of the cases. Higher ASA classifications and age less than 1 year old were significant risk factors for complications (20). Another prospective case study of 1180 cases reported a 2.3% complication rate; 50% of the reported adverse events were oxygen desaturation (21). Despite the institution of sedation-analgesia protocols in all hospitals as mandated by JCAHO, there is wide variability in the training and expertise of the practitioners performing these procedures. In a review of 17,500 computed tomography (CT) scans of the head, performed in pediatric emergency rooms and requiring conscious sedation, only 73% of the practitioners had training in this technique, and 10% were unaware of the national guidelines (22). In order to provide a higher standard of care, dedicated teams in many institutions have been established to provide sedation to children. A retrospective review of one of these services demonstrated a 12% complication rate, most frequently oxygen desaturation, apnea, airway obstruction, and mild hypotension (23). This alarmingly high frequency of complications occurred because the sedation protocol allowed non-anesthesiologists to use drugs that had been restricted to use only by anesthesiologists. In many of these situations, general anesthesia was administered by non-anesthesiologists. For this reason, the report by Lowrie et al. (23) was severely criticized by Krane (24), Yaster and Maxwell (25), and Means et al. of the Section on Anesthesiology of the American Academy of Pediatrics (26). Lowrie et al. replied to these criticisms (27).

Sedation protocols must also be reviewed by the pharmacy and therapeutics (P&T) committee at each institution to assure appropriate dosing for pediatric patients. For non-painful procedures, chloral hydrate is still the most widely used sedative in pediatrics. Sedation failure may be avoided by the use of adequate induction doses (50–100 mg/kg orally). Pentobarbital (2 mg/kg IV to a maximal dose of 5–6 mg/kg) is commonly used for diagnostic radiology when patients are monitored by a nurse. Midazolam administered via the oral, rectal, intravenous, or intranasal route is frequently used in combination with a narcotic such as morphine sulfate, fentanyl or meperidine, or ketamine in sub-anesthetic doses. The advantage of a benzodiazepine-narcotic combination is the availability of specific antidotes in case of overdose. Intravenous general anesthetics have a high potential for respiratory complications, and therefore should generally be used only by anesthesiologists. However, these agents may be safely used in intubated and ventilated patients by non-anesthesiologists. For painful procedures, the addition of local anesthesia may allow reduction in the dose of sedatives. Adequate pain relief in the initial stages of repeated painful diagnostics (e.g., lumbar puncture) may prevent later escalation of sedative requirements (28). EMLA can be extremely useful for these indications and in the emergency room.

Patient safety remains the most important mandate for anesthesiology. New developments in pediatric anesthesia, which hold the promise of enhancing patient and parent comfort, always need to be evaluated to identify and prevent any increased risk. Adherence to national sedation guidelines, institutional protocols approved by the anesthesia department and P&T committee, along with the appropriate monitoring capabilities allows pediatric sedation to be performed safely and effectively by non-anesthesiologists in areas outside the operating rooms. Oversight by the institutional performance improvement and quality assurance committees acts as an additional safeguard. The accepted techniques have all gone through extensive clinical trial and/or scientific scrutiny. The risk of anesthesia is the lowest it has been since the introduction of general anesthesia into clinical practice anesthesia in 1842; however, this safety record can be maintained only if a physician-anesthesiologist is involved in the care of the patients requiring anesthesia (29).

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