Anesthesia for the Pediatric Oral and Maxillofacial Surgery Patient

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KEYWORDS

• Pediatric anesthesia • Training standards in pediatric anesthesia for OMS
• Techniques in pediatric anesthesia

KEY POINTS

- Anatomy and physiology as it relates to pediatric anesthesia is described.
- Current training standards for oral and maxillofacial surgeons in pediatric anesthesia are outlined.
- NPO guidelines for pediatric patients are presented.
- Anesthetic techniques and monitoring for pediatric anesthesia are considered.
- Anesthetic considerations for children with autism spectrum disorders and for children with attention deficit hyperactivity disorder.

INTRODUCTION

Children are not small adults and should never be taken for granted as such while planning administration of pediatric anesthesia in the oral and maxillofacial surgeon (OMS) office. Although OMSs may be astutely familiar and expertly talented in providing anesthesia for adults in their offices, it would not be prudent to apply the same confidence to anesthetizing children outside the operating rooms. The pediatric patient exhibits stark contrasts in their behavioral psychology, anatomy, and physiology, and those differences must be respected when providing anesthesia in this age group. The intent of this article is to identify key anatomic and physiologic differences in the pediatric population and address some common techniques in the safe practice of pediatric ambulatory anesthesia.

ANATOMY AND PHYSIOLOGY

The American Academy of Pediatrics and bodies such as the US Food and Drug Administration define pediatric subpopulations[1] as shown in Table 1.

Airway Anatomy and Pulmonary Physiology in Children

Younger children have disproportionately large heads perched on their tiny necks, connected to a wide thorax of immature cartilaginous ribs atop a large protuberant abdomen. Both tongue and tonsils are also disproportionately large, relative to the size of adjacent anatomy. Additionally, they have small nasal passages and are obligate nasal breathers until they are about 5 months of age.

The geometry of the pediatric airway was long considered to be an arrangement of the cartilaginous and other soft tissue structures in the neck to form a funnel shape. The long floppy epiglottis and an anterior and more cephalad larynx are major differences in the airway anatomy of a child and an adult. The shorter neck of a child makes the position of the larynx at the level of C4, whereas it is

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Table 1
Age-based definitions of pediatric patients

Pediatric Subpopulation	Approximate Age Range
Newborn	Birth to 1 mo of age
Infant	1 mo to 2 y of age
Child	2 to 12 y of age
Adolescent	12 to 21 y of age

much lower in an adult at the level of C6. The notion that the pediatric airway is funnel shaped has been challenged in recently studies involving computed tomography scans of neonates and infants.[2] These studies have suggested that the pediatric airway is an elliptical structure with the subglottic area being the narrowest portion of the ellipse. The elliptical shape is particularly prominent between the subglottic region and the cricoid. Additionally, these studies have shown that the airway is wider anteroposteriorly and narrows in the transverse dimension from the subglottic region to the cricoid. The older the child, the more these airways start assuming the shape of the previously described cone. A previous study by the same group suggested that the subglottic area is the narrowest transversely, and that it is the most likely area of resistance to the passage of an endotracheal tube rather than the area of the cricoid.[3]

There are significant differences in the pulmonary anatomy and physiology in children. Their ribs are more cartilaginous in their composition and more horizontal in their arrangement when compared with adults. This factor increases their chest wall compliance, making them more prone to chest wall collapse during inspiration, and leaves them with low residual lung volumes on expiration. Their lung architecture is characterized by alveoli that are smaller in size and fewer in number. The intercostal muscles and diaphragmatic musculature are weaker. Because the rapidly growing child has increased oxygen consumption, their limited physiologic reserve renders them less able to tolerate hypoxemia, and they desaturate more rapidly and have short safe apnea times Children compensate for the lower volume and reserve by increasing respiratory rate. As such, minute ventilation (tidal volume × breaths per minute) can only be maintained by increasing the respiratory rate. This factor is demonstrated by the finding that the respiratory rate is almost double that of an adult, at any given level of activity (Table 2).

Upper respiratory tract infections (URIs) are common occurrences in children of school age. There is ample evidence to suggest that the increased airway reactivity in children with URIs make them more susceptible to increased risk of respiratory complications under anesthesia. Scientific literature on the topic provides a range of information. For the clinician looking to answer a simple question, "Should we anesthetize a child with a recent mild-moderate URI?", it can sometimes be challenging to distill the data available. There are no case-controlled studies available and almost all of the available information is based on retrospective observational studies. There is some evidence of this type that suggests that children with a mild URI may be safely anesthetized because the problems encountered are generally easily treated without long-term sequelae. Most credible data on this topic also are in the context of airway instrumentation—supraglottic airway or intubation being involved in the anesthetic technique. A recent prospectively conducted study showed that children with URI did worse when a laryngeal mask airway was placed.[4] So, is an OMS who performs a quick and simple procedure in the office with anxiolysis and a nonintubated airway safer while anesthetizing a child with a mild URI? There is no evidence that suggests evidence to prove or disprove that scenario.

When in doubt, postponing the case until the child is well is probably the prudent approach.

Table 2
Comparison of pulmonary physiologic parameters of the child versus the adult

Variable	Infant	Adult
Respiratory frequency	30–50	12–16
Tidal volume (mL/kg)	6–8	7
Dead space (mL/kg)	2–2.5	2.2
Function reserve capacity (mL/kg)	25	40
Oxygen consumption (mL/kg/min)	6–8	3–4

Cardiovascular Anatomy and Physiology in Children

Younger children have a relatively noncompliant and fixed left ventricle. The size of their heart and vasculature increase with age. The limited mobility of the left side of the heart limits diastolic fill and, therefore, the stroke volume. Because cardiac output depends on heart rate and stroke volume, an inherent decrease in stroke volume suggests that the heart rate must increase to maintain cardiac output. Both systolic and diastolic pressures increase with age and increased size of organs (Table 3).

Table 3
Age-related changes in cardiovascular parameters of the pediatric patient

Age	Heart Rate (bpm)	Systolic Blood Pressure (mm Hg)	Diastolic Blood Pressure (mm Hg)
Newborn	110–150	60–75	27
6 mo	80–150	95	45
2 y	85–125	95	50
4 y	75–115	98	57
8 y	60–110	112	60

The immature autonomic nervous system of younger patients blunts their reflex ability to respond to hypotension, via either tachycardia or vasoconstriction. A decreased response to exogenous catecholamines can also be anticipated. Neonates and infants respond to loss of volume by being hypotensive and are rarely tachycardic.

Cardiac arrest in otherwise healthy children is rarely due to true cardiac events. It is almost always pulmonary driven and is a response to hypoxic insults. Hypoxia and respiratory embarrassments trigger bradycardia, hypotension, and, eventually, asystole in children. This is particularly pertinent to the sedated child with potential airway compromise in the OMS office.

The renal and gastrointestinal systems in the pediatric population also deserves mention. Normal kidney function is not reached until a child is approximately 2 years of age. Even older children undergoing anesthesia in the office require meticulous and appropriate fluid administration and dosing of medications.

Summary of Pediatric Anatomy and Physiology

The pediatric airway is more susceptible to obstruction owing to its size and anatomic position. Airway obstruction and respiratory events cause hypoxia quicker in children owing to lack of resilience and reserve. Hypoxia will usually lead to bradycardia, owing to parasympathetic excess. This often leads to hypotension, because cardiac output is heart rate variable in a fixed stroke volume heart. Bradycardia will result in asystole without early and successful remediation.

CURRENT TRAINING STANDARDS FOR ORAL AND MAXILLOFACIAL SURGEONS IN PEDIATRIC ANESTHESIA

The standards mandated by the Commission on Dental Accreditation specify training in pediatric anesthesia to OMS residents.[5] Currently, the standards that pertain to pediatric anesthesia are standards 4-3.1, 4-9, and 4-9.1.

Standard 4-3.1 states: Anesthesia Service: The assignment must be for a minimum of 5 months, should be consecutive and one of these months should be dedicated to pediatric anesthesia. The resident must function as an anesthesia resident with commensurate level of responsibility.

Standard 4.9 states: The off-service rotation in anesthesia must be supplemented by longitudinal and progressive experience throughout the training program in all aspects of pain and anxiety control. The outpatient surgery experience must ensure adequate training to competence in general anesthesia/deep sedation for oral and maxillofacial surgery procedures, including competence in airway management, on adult and pediatric patients.

Standard 4-9.1 states, The cumulative anesthetic experience of each graduating resident must include administration of general anesthesia/deep sedation to a minimum of 300 patients. A minimum of 150 of these cases must be ambulatory anesthetics for oral and maxillofacial surgery. A minimum of 50 of the 300 patients must be pediatric (18 years of age or younger).

The document specifies that “a pediatric anesthesia patient is defined as 18 years of age or younger.”

At the time of preparing this article, the Committee on Education and Training of the American Association of Oral Maxillofacial Surgeons is in the process of recommending some key changes to these standards.

The ability to control anxiety and pain, and to provide anesthesia for our pediatric population is a task that is taken seriously by our training programs. Although minimal numbers do not necessarily ensure competency, they are a definitely a way to guarantee uniform exposure of our trainees to methods to assess the pediatric airway and physiology, and to teach techniques in pediatric anesthesia.

CURRENT EQUIPMENT, PERSONNEL, AND MONITORING GUIDELINES

The optimum care of the pediatric patient under anesthesia in the nonoperating room setting, especially in the OMS office, is guided by several entities.

State and local guidelines may vary as to the recommendations regarding qualification of personnel present during pediatric anesthesia in the OMS office. In general, pediatric advanced life support certification is recommended for key personnel. Although the literature is largely silent on the scientific basis of recommendations and guidelines as it pertains to the ideal number of personnel caring for the child under anesthesia in the nonoperating room setting, it is generally accepted that deeper levels of anesthesia require dedicated monitoring personnel and additional trained hands responsible for the welfare of this child. All personnel are expected to be aware and trained in management of an emergency, should one arise. Pediatric advanced life support protocols standardize responses in the event of an emergency resuscitation.

The American Association of Oral Maxillofacial Surgeons Parameters of Care on Anesthesia[6] states that, although

> *[A]rrests are rare events, and in the anxiety of a pediatric resuscitation the calculation of quickly needed emergency drugs may be particularly challenging. One-page printouts of dosages in milliliters for the known concentrations of the commonly used drugs that would be required for the actual weight of the particular pediatric patient being anesthetized can facilitate a smooth, coordinated, and most likely successful resuscitation.*

Multiple references are available for determining pediatric dosages such as the Broselow Tape, smart phone apps, and a download available from the American Dental Society of Anesthesia.

In general, the American Society of Anesthesiologists (ASA) Practice Recommendations for Pediatric Anesthesia recommends specialized pediatric equipment be readily available. This includes airway equipment for all ages of pediatric patients including ventilation masks, laryngeal mask airways, endotracheal tubes, oral and nasopharyngeal airways, and laryngoscopes with pediatric blades.

Further, a mechanism to provide positive-pressure ventilation appropriate for infants and children must be available, as should intravenous (IV) fluid administration equipment, including pediatric volumetric fluid administration devices, intravascular catheters in all pediatric sizes, and devices for intraosseous fluid administration.

Regardless of the level of anesthesia provided, standard ASA monitoring is recommended, and includes noninvasive size-appropriate monitoring equipment for the measurement of blood pressure, pulse oximetry, capnography, anesthetic gas concentrations, inhaled oxygen concentration, electrocardiography, and temperature as per ASA standards as well as a pediatric precordial stethoscope bell.

Additionally, a resuscitation cart should be stocked with equipment appropriate for pediatric patients of all ages seen in the practice, including pediatric defibrillator paddles and vasoactive resuscitative medications in appropriate pediatric concentrations. Facilities that provide inhalational anesthesia should be prepared with dantrolene sodium and measures to respond to possible malignant hyperthermia (MH) events. Specialized equipment for the management of the difficult pediatric airway by a variety of techniques for airway control, intubation, and ventilation, including but not limited to specialized intubating devices, supraglottic airways, and emergency cricothyrotomy sets, should be stocked and frequently checked during emergency drills and maintained.

A new set of preoperative vital signs, including weight of the child and a focused airway examination before the procedure that includes visualization of the airway and auscultation of the heart and lungs are recommended. Particular attention should be given to the tonsillar size because tonsillar hypertrophy can be an important component of the airway examination. The Fishbaugh classification is used by many to describe tonsillar size. Documentation of these findings should be a part of the anesthesia record.

The anesthesia record itself is a time-oriented anesthesia document with the following components:

- Anesthetic agents, including dosages, routes of administration, and times of administration.
- Continuous monitoring including heart rate, blood pressure, ventilation, arterial oxygen saturation, end-tidal carbon dioxide, and temperature (when indicated) on at least a 5-minute interval; and
- Continuous electrocardiographic monitoring.

NPO GUIDELINES

An Updated Report by the American Society of Anesthesiologists Task Force on Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration published in 2017[7] makes the following recommendations. The guidelines emphasize identifying those patients at increased risk of pulmonary aspiration, namely, those who are obese, have diabetes, and so on. Children in general have a higher incidence of reflux and must be taken into consideration while suggesting NPO orders before planned procedures.

Recommendations for Clear Liquids

Clear liquids may be ingested for up to 2 hours before procedures requiring general anesthesia, regional anesthesia, or procedural sedation and analgesia.

Preoperative Fasting of Breast Milk

For healthy neonates (<44 gestational weeks) and infants, fasting from the intake of breast milk for 4 or more hours before elective procedures requiring general anesthesia, regional anesthesia, or procedural sedation and analgesia should be maintained.

Preoperative Fasting of Infant Formula

Infant formula may be ingested for up to 6 hours before elective procedures requiring general anesthesia, regional anesthesia, or procedural sedation and analgesia.

Preoperative Fasting of Solids and Nonhuman Milk

A light meal or nonhuman milk may be ingested for up to 6 hours before elective procedures requiring general anesthesia, regional anesthesia, or procedural sedation and analgesia. Additional fasting time (eg, $\geq$8 hours) may be needed in cases of patient intake of fried foods, fatty foods, or meat. Consider both the amount and type of foods ingested when determining an appropriate fasting period. Because nonhuman milk is similar to solids in gastric emptying time, consider the amount ingested when determining an appropriate fasting period.

There are currently no separate recommendations for the pediatric population as it relates to the use of preoperative pharmacologic agents for prevention of pulmonary aspiration including gastrointestinal stimulants, antiemetics, anticholinergics, and antacids. As per the guidelines, offering clear liquids[a] up to 2 hours before induction decreases hunger and irritability in the child, keeps them hydrated, and minimizes challenges in starting a peripheral IV line and decreases hypoglycemia.

PEDIATRIC ANESTHESIA TECHNIQUES

Alleviating Anxiety: Premedication in the Pediatric Population

The primary objective of using premedication in (adult or) pediatric patient is to reduce anxiety and allow acceptance or a mask or an IV to proceed with an anesthetic to the next level. A large majority of children are anxious at the appointment for a procedure in the OMS office. An increased sympathetic tone from this anxiety now makes induction and maintenance of anesthesia more challenging. Anxious patients are 3 times more likely to miss appointments and often require more handholding and chair time. Despite the best efforts of the anesthesia team, an unpleasant experience leaves enduring memories for the child and parents and may negatively impact future experiences. The idea of a premedication thus becomes appealing to not only reduce anxiety to “show” for the appointment, but also allows the team to move forward with the anesthetic and surgical plan in a child who is conscious, cooperative, and comfortable.

Premedication can be administered via enteral (oral), parenteral (often intramuscular [IM]), and inhalational routes. Although the enteral route is the least threatening and most convenient way to administer premedication, it has several disadvantages. It primarily relies on the cooperation of the child (and the parent). The dosing is often empirical and the drug cannot be truly titrated. There is a variable response and an equally unpredictable recovery pattern to oral premedication. The often unpredictable and extended times of action of medication may hinder treatment plans on a busy procedure day. Oral predication is often flavored for acceptance by a child and can be available in a variety of creative forms including syrups, popsicles, and lozenges. Nasal sprays are less well-tolerated by children. An ideal premedication should of course be rapidly absorbed, must then have a rapid onset of action with a high therapeutic index, and should not delay recovery. Various medications including benzodiazepines, histamine blockers, opioids, scopolamine, barbiturates, and alpha agonists (dexmedetomidine and clonidine) have been used as premedication.

Several factors, including ease of absorption and limited cardiovascular effects, make benzodiazepines a desirable choice. Drugs in this class commonly used as premedication includes

[a]Clear fluids are limited to water, apple juice, black coffee without milk cream or creamer, clear tea, Gatorade, infant electrolyte solutions (Pedialyte), and clear carbonated beverages.

diazepam, triazolam, and midazolam. Oral midazolam in a liquid form is well-tolerated by children. These 3 medications have some characteristic differences (Table 4).

Diazepam has had a long history of use and has been proven to reduce preoperative anxiety and is well-studied in the pediatric population for its efficacy and safety. It has proven to not delay discharge. In very young patients, it is safer to administer it in the office even as a premedication because of its effects on postural stability.

Oral midazolam has a rapid onset of action, short duration of action, leaves no active metabolites, and has the desirable effect of retrograde amnesia. It is available as pleasantly flavored syrups and popsicles, and is easily accepted by the child. The dosing recommended for premedication is 0.5 to 1.0 mg/kg with a 15- to 20-mg maximum dose. This dose is expected to be effective for approximately 30 minutes. This oral dose should not affect heart rate, respiratory rate, or blood pressure significantly. The major disadvantages of this drug is that it does not provide any analgesic effects. Furthermore, 3% to 4% of children can have paradoxic responses to midazolam causing dysphoria, blurred vision, and undesirable behavior. Like all other oral premedications, oral midazolam also may be difficult to titrate, may have unreliable absorption, and moderate failure rates. Other medications such as triazolam have not been well-studied in children.

Dexmedetomidine is gaining popularity as a single agent sedative for MRI or simple procedures. It is an alpha$_2$ agonist and not a GABA-mimetic drug like benzodiazepines or propofol. Its significant advantage is that the sedation it provides mimics natural sleep, anxiolysis, analgesia, sympatholysis, with minimal respiratory depression. The current recommended dose for premedication purposes are 3 to 4 μg/kg intranasal and 1 to 4 μg/kg dosing orally.

Ketamine is another drug that can be used for oral premedication. The dose recommended is 6 mg/kg. At this dose, it typically takes 20 minutes to onset and can provide sedation lasting up to 30 minutes.

Table 4
Comparison of diazepam, triazolam, and midazolam

Drug	Onset	Elimination
Diazepam	Rapid	Slow
Triazolam	Intermediate	Very rapid
Midazolam	Very rapid	Rapid

Parenteral Routes of Anesthesia

Intramuscular anesthesia technique

The greatest advantage of this route of administration of anesthesia is a certain predictability of onset of anesthesia, even for the most uncooperative of children. The disadvantage is that the rapidity of the onset of anesthesia depends on the drug used and the site of injection, and that it has the potential to be an unpleasant experience for a cooperative child. Many medications including benzodiazepines, ketamine, and dexmedetomidine have been used in the IM technique.

Ketamine seems to be the more commonly choice of OMSs using this route. Ketamine is a drug that is a potent analgesic and amnesic that is known to dissociate the cortical and limbic system, thus disrupting the interpretation of visual, auditory, and painful stimuli. It provides what is referred to as dissociative anesthesia. In subanesthetic doses, it can provide analgesia without respiratory depression and can reduces narcotic requirements. The recommended IM dose of ketamine is 3 to 4 mg/kg. Practitioners often add a benzodiazepine such as midazolam and glycopyrrolate to the same syringe as the ketamine to enhance its action and reduce some of the undesired side effects. Ketamine can cause increased salivation, heart rate, blood pressure, and intracranial pressures. It stimulates smooth muscle dilatation, which reduces the risk of bronchospasm. It is important to note that ketamine comes in 2 concentrations, 50 mg/mL and 100 mg/mL. The higher concentration is desirable for IM injection to minimize volume at the injection site. For larger children, the lower concentration can result in injection volumes that exceed 3 mL, which is not recommended for a single site.

A phenomenon called emergence delirium is associated with the use of ketamine that makes practitioners wary of this drug. The concomitant use of benzodiazepines or propofol can reduce the risk of ketamine-induced delirium. The following have been identified as risk factors for emergence delirium with the use of ketamine:

- Female gender;
- Age greater than 10 years;
- Underlying psychiatric disorder;
- IV route;
- High dose; and
- Excessive noise stimulation upon emergence.

The IM technique requires preparing the parent and the staff for IM injection, especially in the uncooperative child; a quiet room with minimal stimuli and provision of enough time on the schedule for the onset of action of anesthesia is ideal for this technique. Monitors must be placed as soon as the child becomes cooperative and should remain in place until discharge. Preparation to escalate to another route of administration of the anesthetic or redosing IM route can be helpful. Longer recovery times can be anticipated with higher preoperative IM dosages.

Intravenous anesthetic technique

The IV route remains the most predictable route of administration of both anesthetic and resuscitation medications. It offers the advantage of rapidity of onset and offset of medications. It does require the placement of a catheter in a peripheral vein, which can be challenging in pediatric patients. Meticulous administration of both the drugs and the fluids require that size appropriate equipment be available, as discussed earlier. Preoperative calculation of drug doses both for anesthesia and emergencies is mandatory. Many apps available on mobile devices and dosing calculators are available on the Internet for accuracy.

Drugs such as benzodiazepines, opioids, ketamine, and propofol remain the mainstay in pediatric IV anesthesia in weight appropriate doses. Single drugs or combinations of these medications provide appropriate environment to perform a procedure achieving the desired goals of anxiolysis, amnesia, analgesia, immobilization, sedation, and hypnosis. The IV route provides safety, rapid onset, rapid offset, and predictable recovery. The IV catheter is recommended to be maintained until discharge and the recovery areas need to be equipped with IV/IO equipment in case of premature loss of this angiocatheter.

Using an infusion pump for longer procedures minimize fluctuations in drug serum concentrations, ensuring a smoother intraoperative anesthetic course. Typically, the pump ensures enhanced cardiovascular and respiratory stability, less patient movement, and often a more rapid recovery because it essentially uses less drug.

Availability and training in the use of an intraosseous access device is also recommended in facilities that choose to treat children. The placement of an IV in a child requires skill and patience, and can be challenging. The increased incidence of obesity in children poses an added level of difficulty to this. In the event of difficulty in procuring a peripheral vascular access, the most reliable alternative is IO access, especially in an emergency.

Inhalational anesthesia technique

Dentists have been familiar with inhalational anesthesia technique using nitrous oxide since 1844. Nitrous oxide has had a proven wide margin of safety and has few side effects in the pediatric population. It is rapid on induction as well as emergence, and is a potent analgesic. We have known that it causes insignificant cardiovascular and respiratory changes. When added to a second inhalational agent, it promotes anesthesia through second gas effect.

Inhalational techniques are much better tolerated and perceived as less invasive. Typically, a mask is well-accepted by a curious child, especially when an added fruity smell detracts from the unpleasant odor of a plastic mask. In most instances, the anesthetic gas(es) are rapidly delivered and onset of anesthesia is quick. In noncooperative children, crying actually helps, with long deep breathes during crying ensuring that the lungs are filled with the anesthetic agent.

Sevoflurane has become the inhalational agent of choice in most OMS offices. It is a halogenated ether with a fast onset of action and predictable recovery. It has a sweet, slightly pungent fruity odor that enjoys decent patient acceptance. The gas itself does not irritate the airway compared with other options, and induction is characterized by a decreased incidence of breath holding and laryngospasms. It has been proven to be safe to be used with local anesthesia with epinephrine. Standard ASA monitoring including preoperative temperature measurement is recommended while using inhalational agents. If sevoflurane is used for procedures that last more than 30 minutes, it is recommended that continuous invasive temperature monitoring be considered.

In cooperative children, preoxygenation for several minutes before induction is ideal. Sevoflurane can be used as a single inhalational agent or in conjunction with nitrous oxide. Incrementally titrating the gas to effect is ideal. Often, once the patient is past stage II of anesthesia, starting an IV and administering anesthetic drugs through that route is preferred. The gas inhalation is stopped and the patient is maintained on mask or nasal cannula O_2 at that juncture.

In uncooperative children, a single breath technique is effective. The circuit is primed with 8% sevoflurane. Preoxygenation is often not practical in a crying child. The mask is placed with some force, often while the child is seated in the parent's lap. Crying promotes quick inhalation of the concentrated gas and induction is rapid. Upon induction, an IV may be placed, the gases discontinued, and the technique converted to a total IV anesthetic.

It is prudent to consider the placement of an IV in all inhalational anesthetics. This is especially true if the patient is relatively small, obese, or younger, or in any circumstance that the anesthesia provider deems that placement of an IV may be a challenge, especially in the event of an untoward event. That IV may never be used, but serves as a safety net. It is best placed when things are under control and before beginning of the procedure rather than in an emergency or midprocedure.

Halogenated gases are triggers for MH. A focused family and personal history regarding the potential for MH should be discussed with patients and parents before planning an inhalational anesthetic. Facilities that use MH triggering agents are recommended to be prepared for an MH event. This preparation includes storing adequate amounts of dantrolene and practicing how to reconstitute it. Newer dantrolene products have made this process less cumbersome, in addition to reducing the amounts of dantrolene that need to be stored.

Safe Discharge

The concept of safe discharge is often overlooked in our busy practices. Although healthy adults and adolescents may recover rapidly from anesthesia delivered in the OMS office, the pediatric population requires a higher level of care and diligence before discharge. The ASA mandates that recovery be:

> *[P]rovided in an area that allows pediatric perioperative care, including the management of postoperative complications and the provision pediatric cardiopulmonary resuscitation, and a provider trained and experienced in pediatric perioperative care, should be made immediately available to evaluate and treat any child in distress. Patient-care facilities (including ambulatory surgical centers) that perform operative procedures for which postoperative intensive care is not anticipated may develop a proactive, clearly delineated plan (ie, a "transfer agreement") to transfer children to an appropriate hospital facility when complications requiring inpatient monitoring/care occur.*[8]

Postanesthetic laryngospasms are more common in the pediatric population. Hence, recovery in a lateral position is recommended to avoid secretions irritating chords. State of consciousness, assessment and documentation of vitals, age-appropriate ambulation, pain control, and the absence of postoperative nausea and vomiting is required before discharge. Two responsible adult escorts riding in the same vehicle accompanying a child home is a safe practice after pediatric anesthesia. In the event of narcosis, postdischarge vomiting and aspiration or inadequate postoperative pain control, having a second adult to assist the patient other than the driver of the vehicle simply makes everything safer.

The administration of a reversal agent during the anesthetic would warrant a longer recovery period because many of these agents have a shorter duration of action than the sedative drugs themselves and the risk of resedation is often imminent. A minimum of 1 hour after administration of a reversal agent is recommended to ensure resedation does not occur before discharge. There is no mandated time period for recovery before safe discharge in either adult or pediatric sedation in the OMS office. Most practitioners and institutions adopt a standard discharge criteria documentation such as a modified Aldrete score or a Richmond Agitation-Sedation Scale. Regardless of the method of documenting discharge and recovery, like everything else in pediatric anesthesia, a pinch more of diligence is required to avoid complications in this vulnerable population.

ACCOMMODATING CHILDREN WITH SPECIAL NEEDS

OMSs are seeing an increased presence of children with special needs such as those in the autism spectrum disorders and attention deficit hyperactivity disorders (ADHD) in our offices.

Autism Spectrum Disorders

The Centers for Disease Control and Prevention estimated in 2016 that 1 in 68 children (1 in 42 boys and 1 in 189 girls) have autism in the United States. Children with autism spectrum disorder have varying levels of social communication and interaction as well as other clinical features. This finding suggests that treating these children in the office often requires a level of personalized care especially as it relates to the provision of anesthesia. Some of these patients may be high functional without any psychological or physiologic burden of the condition, and can be essentially treated the same as any other child. The other end of the spectrum might be an extremely uncooperative child with severe behavioral issues who may simply not be an ideal candidate for office-based anesthesia. This spectrum of cooperation and the awareness of comorbidities should influence the anesthetic plan.[9]

In general children, with autism spectrum disorder do better in familiar surroundings, predictability, and structure. Keeping consultation visits close to the procedure appointment helps with that. During consultation visits, allow the child to manipulate instruments and materials, such as holding the mask, and consider sending a mask home with the child for them to get familiar with. It helps to engage the child using a mobile app.[10]

For those children with lower-level language abilities, using simple language, speaking clearly, and avoiding abstract language and figures of speech, as well as using visual cues and supports and keeping instructions simple, help tremendously. It helps to take time to know the child's likes, dislikes, favorite activities, negative triggers, and coping techniques, and to involve parents in preoperative decisions. Premedication may be beneficial, especially in those with severe intellectual disability, but be aware that these children have specific likes and dislikes of textures and tastes. Considering mixing in the child's favorite drink in the context of NPO guidelines is a practical tip.[11] Recovering in the presence of parents or a favorite toy for a prolonged period of time is often helpful.

Attention Deficit Hyperactivity Disorder

ADHD is a brain disorder marked by ongoing pattern of inattention and/or hyperactivity–impulsivity that interferes with function or development. It is estimated that world-wide its prevalence is approximately 5% to 7% in children and adolescent (approximately 5% in the United States).[12] Although it is considered a condition of the childhood, about one-half of the time, it persists into adulthood. Males are generally more affected than females. The 3 key behaviors of children with ADHD are:

- Inattention;
- Hyperactivity; and
- Impulsivity.

Although it is normal to have some inattention, unfocused motor activity, and impulsivity in child, in children with ADHD, these are more severe, occur more often, and interfere with or reduce the quality of function socially, at school, or at work. There is no proposed cure for ADHD, but treatment is aimed to reduce symptoms and enhance social function. Modalities of managing ADHD include medications, psychotherapy, education or training, and often a combination of these.

Medications for ADHD basically fall into 2 categories—stimulants and nonstimulants (Table 5). The real question for most practitioners is how to manage these medications for office-based anesthesia in these patients. Children with ADHD exhibit significantly less cooperative behavior at the induction of anesthesia as well as increased level of maladaptive behaviors postoperatively, such as an increase in temper tantrums or fidgety behavior. Having said that, there is evidence to suggest that children with and without ADHD undergoing procedural sedation showed that these children were equally sedated with the same total drug dosages.

The literature is also conflicting and scant regarding continuing versus withholding common ADHD medications for general anesthesia. Psychostimulants are thought to increase the risk of hypertension and arrhythmias, decrease the seizure threshold, and blunt the physiologic response to hypotension owing to a depleted catecholamine reserve. However, there are no reports of any cardiovascular instability in patients with chronic amphetamine use undergoing general anesthesia while continuing the amphetamine regimen. Although methylphenidate has a specific contraindication to the concomitant use of a halogenated anesthetic owing to the risk of sudden blood pressure increase, there is not a clear contraindication or evidence-based protocol for continuing or withholding other psychostimulants perioperatively.

When selective serotonin reuptake inhibitors are used as a nonstimulant therapy for ADHD, the anesthesia provider will need to pay close attention bleeding risk owing to possible interaction with platelet aggregation. The anesthesia provider will need to consider the bleeding risk from surgery as well as the severity of the underlying psychiatric problem when considering continuing, switching,

Table 5
Common medication regimen for attention deficit hyperactivity disorder

Stimulants	Nonstimulants
Amphetamines (Adderall, Vyvanse)	Atomoxetine (Strattera)
Methamphetamine (Desoxyn)	Selective serotonin reuptake inhibitor antidepressants
Methylphenidate (Concerta, Ritalin)	

or discontinuing a selective serotonin reuptake inhibitor in the perioperative period, preferably with a psychiatric consultation.

DRAWING A PERSONAL LINE WITH PEDIATRIC ANESTHESIA

Providing safe anesthetic care in the OMS office is not a trivial task. Recent reports of untoward events and complications that have led to both mortality and morbidity when anesthetics were administered to children outside the operating room setting, especially in dental offices, brings to light the risks and vulnerability of nonanesthesiologists providing anesthesia. Although OMS training programs provide rigorous training and validation of competency in provision of anesthesia outside the operating room, when adverse events occur, all nonanesthesiologists are equally vindicated. Although all OMS training programs in the United States train to the same minimum standards, not all training is the same. Trainees may be exposed to varying quality and quantity of cases during their training.

OMSs who take on the responsibility of offering pediatric anesthesia in their offices must take a hard look at their ability to safely provide it. How young a child are you prepared to anesthetize in the office? Is your office and your staff prepared for anesthetic emergencies in pediatric anesthesia? Is your training and equipment appropriate to perform safe pediatric anesthesia? Do you routinely perform emergency drills with scenarios involving pediatric adverse events? Is performing pediatric anesthesia a risk you need to take on in today's world? That is a personal line that one must draw after reviewing all the factors mentioned (and more) objectively.

SUMMARY

Children are not just small adults. Clear differences in the anatomy and physiology of a child requires additional training, skills, and techniques in performing anesthesia for a child in our offices. This article reviewed the salient differences in the anatomy and physiology of a child as they pertain to the provision of anesthesia in an OMS office. It also reviewed training standards in pediatric anesthesia in OMS training programs and current guidelines for the safe care of these patients in our offices. Common anesthetic techniques were discussed as they pertain to the pediatric population. Further, the management of children with autism spectrum disorder and ADHD were discussed.

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