Evaluation and Preparation of Pediatric Patients Undergoing Anesthesia

Primary health care providers should play a leading role in the medical evaluation and psychological preparation of children before surgery or other procedures requiring anesthesia. The provider’s goal is to ensure that the child’s medical issues are clearly defined and that the physiologic impact and limitations imposed by each condition are well delineated. The primary care provider’s knowledge of the patient’s past medical history and the results of an appropriate physical and/or laboratory evaluation before anesthesia and surgery can provide valuable information to both the anesthesiologist and the surgeon in making the determination as to whether the procedure should take place.

The objectives of this review are threefold:

1. To describe medical issues of concern to anesthesiologists and surgeons to improve the effectiveness of medical consultations in the preoperative period;
2. To present information that will encourage and facilitate communication among surgeons, anesthesiologists, pediatricians, and other primary health care providers; and
3. To provide guidelines to pediatricians and other primary health care providers who are preparing patients and families for anticipated procedures.

ROLE OF THE SURGEON

The preoperative evaluation and preparation begins in the office of the primary health care provider. The referral to a surgeon should include a description of what the child and parent should expect during the visit to the surgeon. This will help reduce their anxiety and improve the interaction with the surgeon.

Three types of patients for whom surgeons are typically consulted for evaluation and treatment are:

- The healthy child who is undergoing elective surgery;
- The chronically ill child who requires surgery, and
- The acutely ill or injured child who requires emergent surgery.

When elective surgery is anticipated, the primary provider should communicate directly with the surgeon by written correspondence and sometimes by phone.

The preoperative consultative evaluation by the surgeon will include a history of the current surgical problem, past medical history, a physical examination, and, if indicated, scheduling of preoperative laboratory and/or diagnostic studies. The surgeon will explain the surgical procedure to the parent and child and will include discussion of potential complications, postoperative care, anticipated outcome, and follow-up. The family should also be informed that surgery will likely be cancelled if a concurrent illness develops that would compromise the procedure, anesthesia, or postoperative recovery. The need for blood transfusion, as well as options for donation, should be discussed. The surgeon should communicate with the primary provider regarding the consultation. Adequate planning linking the primary care provider, surgeon, anesthesiologist, and other pertinent medical specialists is essential.

ROLE OF THE ANESTHESIOLOGIST

Anesthesia blunts the input and output of sensory, reflex, mental, and motor functions. It begins with the administration of agents that alter these activities. Anesthesia may begin outside the operating room with the administration of preoperative medication or after the patient enters the operating suite. The involvement of the anesthesiologist extends into the postoperative period until the patient is discharged from the postanesthesia care unit (PACU) or after release from the PACU if regional analgesia or “blocks” have been used for pain relief.

PREOPERATIVE PREPARATION

Anesthesiologists, surgeons, pediatricians, and other primary health care providers, nurses, and other health care personnel participate in preparing the child for anesthesia and surgery. Although each provider of care has his or her own perspective, many issues are common to all. The preparation should include the entire family if so desired by the family. Family members must be afforded an opportunity to express anxieties and concerns on an individual basis and to determine how they can be most supportive of the child during the perioperative period. Because young children are concrete thinkers, explanations and answers to questions asked during the perioperative evaluation should be phased carefully (refraining from using words such as "shots" or "put to sleep") to help allay the child’s fears. Additional sources of family support, such as tours of the operating room, written and audiovisual materials, and patient care representatives skilled in the preoperative preparation of children, are preferred.
INFORMATION OF IMPORTANCE TO THE
ANESTHESIOLOGIST AND SURGEON

History of the Present Illness
The duration of illness and degree of incapacitation are often related to the degree of patient compromise (eg, hemodynamic, respiratory, renal, and hydration status).

Past and Current Medical History
Whether an underlying condition is related to the problem for which surgery is planned, it still may significantly influence how the anesthesiologist and surgeon treat the patient (eg, in a case of a child with a history of croup who has a bowel perforation presenting for emergency exploratory laparotomy).

Medications
Information on current medications as well as those that had been previously taken is important. This should include the use of over-the-counter medications, such as aspirin and other nonsteroidal agents. Also, the patient’s compliance with taking the medication should be noted.

Known Allergies
Allergies to drugs or other substances (eg, eggs or latex) should be noted.

Previous Anesthetic Experiences
Most notably, information about difficulties or complications encountered in previous anesthetic experiences should be obtained, especially those related to intubation or respiratory or cardiovascular compromise. Also important are events that may have been influenced by anesthesia, such as nausea and vomiting or prolonged muscle weakness.

Family History
Anesthetic-related complications such as malignant hyperthermia or prolonged paralysis after an anesthetic (pseudocholinesterase deficiency) are sought. A family history of bleeding tendencies, muscular dystrophy, or drug use is also significant.

Ingestion of Food or Drink
Knowledge regarding the time of food or drink ingestion is vital to assess the potential risk of aspiration during sedation and anesthesia.

Physical Examination
Emphasis of the examination should be on the airway, cardiovascular, respiratory, and neurologic systems and the body system that is pertinent to the specific operation; hydration status; and other organ systems as they relate to the present illness or significant past medical illnesses.

Pertinent Laboratory Evaluation
In recent years the value of screening tests in otherwise healthy surgical patients has been reexamined. Preoperative laboratory tests are now most often used for specific diagnostic purposes or to establish important baseline values (eg, hemoglobin [Hgb] determination in anticipation of major blood loss). Although there are no uniform guidelines for the use of preoperative laboratory tests, the following discussion of specific tests may help address common questions.

Hgb Determination
Hematologic screening of healthy children before elective surgery is unnecessary. Asymptomatic mild abnormalities in Hgb concentration are common in children but require laboratory testing for detection. However, anesthetic management and the postoperative course would not be affected by mild anemia (Hgb >9.5 g/L). Similarly, asymptomatic, mild abnormalities of the white blood cell and platelet counts have no impact in the perioperative period. Hgb concentrations should be measured when significant anemia (<9 g/L) is suspected (eg, infants, growing premature infants, and patients with chronic illnesses) or to establish a reference point in anticipation of significant surgical blood loss.

Pregnancy Testing
Although teratogenicity of anesthetic agents has not been established, a determination of whether a female patient is pregnant should be ascertained before the administration of anesthesia. A request for a pregnancy test might be declined by parents who think that their daughter is not sexually active. Also, a reliable menstrual and sexual history may be difficult to obtain from an adolescent in the surgical suite, where a relationship of confidentiality with nursing and medical personnel has not been previously established. The referring physician who knows the patient may be able to advise how best to proceed when questions arise. Whether pregnancy screening of all female patients of childbearing age before the administration of anesthesia is routine or selective is a matter of policy at individual facilities. The practitioner should be familiar with local guidelines.

Coagulation Screening
Coagulation screening has been among the most debated of all laboratory tests. Although an undiagnosed coagulopathy could result in serious surgical morbidity, commonly used screening tests, such as bleeding time, prothrombin time, activated partial thromboplastin time, and platelet count, do not reliably predict abnormal perioperative bleeding.

Laboratory testing should be considered in patients in whom either the history or medical condition suggests a possible hemostatic defect, in patients undergoing surgical procedures that might induce hemostatic disturbances (eg, cardiopulmonary bypass), when the coagulation system is particularly needed for adequate hemostasis (eg, tonsillectomy), and in patients for whom even minimal postoperative bleeding could be critical (eg, those patients undergoing neurosurgery).

In obtaining a history of bleeding tendencies in the patient or family, it should be remembered that a history of “excess bruising” is often a matter of pa-
bleeding after minor trauma (including dental extraction). Recent ingestion of aspirin or other nonsteroidal antiinflammatory drugs should not be overlooked, particularly when they are included in over-the-counter remedies. Even with careful history taking, mild forms of von Willebrand's disease, platelet dysfunction, or factor deficiencies (eg, factor XI) may easily be missed. In the case of minor surgery and a negative history of clotting disorders, no tests are suggested. It is accepted that there will be a few patients who will have more bleeding than anticipated because of a hemostatic defect, despite a negative family history. However, the overall cost and difficulty of detecting them preoperatively does not warrant routine laboratory testing.

In cases in which the decision is made to obtain preoperative coagulation tests, a small number of patients with negative bleeding histories will have prolonged partial thromboplastin times. Surgery in these patients may be postponed until the defect is defined, although in the majority of cases it is found not to be related to a clinical bleeding disorder.

**Urineysis and Chemistry Screening**

Routine microscopic and chemical testing of urine is insufficiently sensitive and too nonspecific to be of clinical utility in detecting asymptomatic disease that would have an impact on perioperative management. Therefore, such testing is not a useful preoperative screening test. Blood chemistry analyses are usually performed only for specific indications.

In summary, obtaining routine preoperative laboratory screening tests in healthy children is no longer recommended. Specific indications or histories suggesting the presence of illness or certain conditions are more likely to result in positive laboratory investigation.

**SPECIAL ISSUES FOR PRIMARY HEALTH CARE PROVIDERS: ANESTHESIA AND COEXISTING HEALTH PROBLEMS**

**Pulmonary**

*The Child With a Cold*

Numerous publications address the potential risks (eg, atelectasis, oxygen desaturation, bronchospasm, croup, and laryngospasm) of anesthetizing a child who either has or is recovering from a recent upper respiratory tract infection (URI). Consensus exists among many anesthesiologists that an otherwise healthy child who is recovering from a URI without significant residual symptoms may be anesthetized for short minor procedures. Laryngospasm during induction and bronchospasm after tracheal intubation may be more common in the child with a URI. There also may be an increased incidence of Hgb desaturation and hypoxemia in both the operating room and the PACU. These usually do not cause significant morbidity and are treated with routine oxygen supplementation. The studies have not addressed the issue of children who have acute onset of URI symptoms, who are obviously ill, or who are recovering from URIs but are to undergo prolonged or invasive surgery, who may benefit from delaying the procedure unless it is urgent. It is unclear how long surgery should be delayed, because bronchial hyperreactivity, as demonstrated by spirometric changes, may exist for 7 weeks or longer after a URI. Most authors recommend waiting until the acute symptoms have resolved (although not necessarily until full recovery occurs) before proceeding with anesthesia and surgery. The final decision would take into account the risk-to-benefit ratio of the procedure.

**Asthma**

Whenever possible, children with asthma should be under optimal medical control before receiving anesthesia. All medications should be continued up to and including the day of surgery. Oral medications in the form of tablets may be taken with 1 or 2 oz of water up to 1 to 2 hours before surgery, and inhaled bronchodilators may be administered before surgery.

**Cystic Fibrosis**

Children with cystic fibrosis almost always have malnutrition and chronic pulmonary infection. They often need vigorous preoperative chest physical therapy and postural drainage as well as intravenous antibiotic therapy. Many will need parenteral nutrition or supplemental enteral nutrition before a procedure.

**The Former Preterm Infant**

There are many concerns related to the perioperative period of former preterm infants. Two frequent problems are the impact that bronchopulmonary dysplasia might have on the patient's perioperative course and the possibility of postoperative apnea. The former preterm infant may also have mild bronchopulmonary dysplasia or extensive disease with chronic hypoxemia and hypercarbia, tracheomalacia, or bronchomalacia and increased pulmonary vascular resistance with cor pulmonale. Diuretics, bronchodilators, and corticosteroids, which many of these patients require, affect treatment and should be continued up to and including the day of surgery. There are numerous reports of apnea in former preterm infants after anesthesia. However, it is difficult to determine which infants are at risk. Reports identify a range of postconceptional or gestational ages of at-risk patients, varying methods used to detect apnea or periodic breathing, and a variety of surgical procedures. Even apnea is defined differently in different reports. Analysis of the most frequently cited studies suggests that anemia (hematocrit <30%), apnea at home (home apnea-monitoring equipment), postconceptional age, and gestational age are all important risk factors for post-
operative apnea. This would support claims that the risk of postoperative apnea is inversely related to postconceptional age and that infants with prior histories of apnea and bradycardia, respiratory distress, intubation, and mechanical ventilation may be at increased risk. Recently, there have also been reports of abnormal breathing patterns in full-term infants. Arrangements for precautionary overnight observation and monitoring should be made for any child considered to be at significant risk for postoperative apnea, and the parents should be counseled accordingly. At a minimum, the former preterm infant should have a recent determination of hematocrit or Hgb available, because anemia (hematocrit <30%) is associated with an increased incidence of postanesthetic apnea, and this risk is apparently unaffected by postconceptional age.

Cardiac

The child with a murmur poses several problems for the anesthesiologist. Is the murmur “innocent” or pathologic? If pathologic, what is the degree of physiologic compromise or hemodynamic consequences? Does the patient require prophylaxis for subacute bacterial endocarditis? The answers to these questions should be determined before the day of surgery, and a course of action should be decided on by those physicians caring for the child—the pediatrician, the surgeon, the anesthesiologist, and, possibly, a cardiologist. A preoperative visit to the cardiologist may be essential for a child with complex congenital heart disease. Cardiac catheterization data and recommendations should be forwarded to the surgeon and anesthesiologist to plan the anesthetic and surgical preoperative, intraoperative, and postoperative care better. The guidelines of the American Heart Association provide direction for the appropriate administration of prophylaxis for subacute bacterial endocarditis.

Central Nervous System

Myelomeningocele

The infant presenting for closure of a myelomeningocele should be evaluated for congenital anomalies, and the anesthesiologist and surgeon should be informed of coexisting conditions. Approximately 90% of these infants require procedures for diversion of cerebrospinal fluid for the treatment of hydrocephalus and will subsequently require additional surgery secondary to infection, malfunction, or simply outgrowing the cerebrospinal fluid shunt hardware. They also have urogenital and musculoskeletal system dysfunction, resulting in frequent urinary tract infections, renal reflux, scoliosis, lower-extremity abnormalities, and other conditions that frequently are amenable to surgical intervention. Evaluation of abnormal renal and respiratory function provides valuable information to the anesthesiologist and surgeon for perioperative management. Children with myelodysplasia have a high incidence of latex sensitivity, which can be manifested as anaphylaxis during surgery. Signs and symptoms of latex allergy should be sought. Pediatricians and other primary health care providers should work with surgeons, anesthesiologists, and nursing staff in an attempt to provide a latex-free hospital environment for these and other at-risk patients.

Seizure Disorders

The type of seizures, medication, and the frequency of the child’s seizures should be recorded. Whether the seizure disorder is under optimal control and, if not, what constitutes optimal control is useful information for the anesthesiologist. Unless there is a contraindication, anticonvulsants, like most medications, should be administered on schedule or nearly so. Capsules or tablets can be taken with 1 or 2 oz of water 1 to 2 hours before surgery. Suggestions regarding perioperative seizure medication management would also be helpful to the surgeon and anesthesiologist.

Risk of Cervical Spine Instability

Patients with mucopolysaccharidoses (especially Hurler’s and Morquio’s syndromes) may have hypoplasia or absence of the odontoid process, leading to cervical spine instability. Patients with rheumatoid arthritis also have a high incidence of cervical spine abnormalities, including atlantoaxial instability, subaxial instability, and superior migration of the odontoid process. Approximately 15% of children with Down syndrome are estimated to have asymptomatic atlantoaxial instability (greater than 4 to 5 mm distance from the posterior surface of the anterior atlas to the anterior surface of the odontoid process of the axis), and 1.5% have symptomatic atlantoaxial subluxation. Although a consensus does not exist regarding the treatment of these children, one group of authors recommends flexion-extension roentgenograms as a screening procedure, along with neurosurgical or orthopedic consultation in symptomatic or high-risk patients.

Hematologic Disorders

Heterozygous sickle cell trait is not likely to increase perioperative risk for routine procedures, but the sickling conditions (HgbSS, HgbSC, and HgbS-β thalassemia) are of great concern. Acute chest syndrome, stroke, myocardial infarction, and other forms of “crisis” are real dangers in the perioperative period. In the past 20 years, it has been common practice to reduce the risk of these events by preoperative transfusions to reduce the total HgbS level to less than 40%. Although it is likely that perioperative morbidity in patients with sickle cell disease has lessened, it is not certain whether this is solely due to better management of factors contributing to the evolution of crisis. With increasing concerns about transfusion, many anesthesiologists, surgeons, and hematologists have modified their practices regarding the need for perioperative transfusion in certain surgical procedures. Planning for anesthesia and surgery in all patients with sickle cell disease must begin in advance of the surgery; coordination among the pediatrician, hematologist, anesthesiologist, and surgeon is essential.
Metabolic Disorders

Diabetes

There are many successful regimens for the treatment of diabetic children during the perioperative period. Often cases are scheduled early in the day. Usually intravenous access is established, an infusion of a crystalloid containing 5% glucose is begun, and a portion of the patient's morning insulin requirement is administered. Serum glucose levels usually are monitored both intraproactively and in the PACU. It is helpful for the anesthesiologist to know the acceptable range of serum glucose levels for the individual patient. Also, recommendations for when and what type of intervention may be appropriate for maintaining desirable blood glucose levels will be of benefit.

Oncologic Diseases

Children with malignant diseases may have received treatment that will directly affect the anesthetic and surgical management. A summary of the disease process and treatments should be available before the time of surgery. A list of all chemotherapeutic agents should be included, because both myocardial and pulmonary function may be altered by a variety of drugs (eg, doxorubicin, daunorubicin, and bleomycin). Areas of radiation therapy should be indicated, because anatomic function may be altered (eg, the inability to open the mouth after radiation therapy to the jaw). A recent complete blood cell count should be available to help evaluate the need for red blood cell or platelet transfusion before or during surgery. A chest radiograph is indicated in those patients who may have thoracic involvement of their disease. Children who have masses in the mediastinum, especially the anterior mediastinum, have special risks during induction of anesthesia and must be treated accordingly. Evaluation should include inquiries about dyspnea, orthopnea, cough, fainting, cyanosis, and other signs or symptoms of compromise. Computed tomography or magnetic resonance imaging provides essential information on tracheal, bronchial, superior vena caval, and pulmonary arterial compression. Flow-volume loop curves obtained with the older patient in upright and supine positions assess the functional degree of impairment. Echocardiography may help delineate cardiovascular involvement. The potential for dynamic airway collapse or hemodynamic compromise during anesthesia can have grave consequences. In the child in whom respiratory or cardiovascular compromise is suspected, the above studies should be obtained, when possible, before surgery. In some patients it may be advisable to avoid anesthesia until after treatment has been initiated.

Cancellation on the Day of Surgery

When the child arrives at the hospital on the day of surgery, any recent change in physiologic status, such as fever, respiratory symptoms, or malaise, must be evaluated before the induction of anesthesia. The decision to operate will frequently depend on the urgency of the surgery, the duration and complexity of the surgery, and the need for instrumentation of the airway. A consensus is sought from the parents, surgeon, anesthesiologist, and, in some cases, the primary care or referring physician with respect to the decision to proceed with the operation in these less than ideal circumstances.

Common Parental Questions

What is “NPO”?

NPO (nil per os) is the directive given to patients and their families concerning the timing of the fasting period before surgery. The preoperative fast is an attempt to avoid particulate matter and liquid from the child's stomach being vomited and aspirated during the induction of anesthesia. Guidelines for preoperative oral intake have undergone extensive revision. Recent studies have shown that the limited intake of a clear liquid (a liquid that one can see print through, such as sugar water or apple juice) up to 2 or 3 hours before anesthesia does not significantly increase the volume in the stomach or alter the pH of the gastric contents (both of which may increase the risk of aspiration pneumonitis). In addition to not increasing the risk of aspiration, consumption of clear liquids is better accepted by the fasting child. Parents and the child should be cautioned against solid food or nonclear liquid intake during the NPO period. Each hospital has its own policy. It is beneficial to know local policy when discussing fasting requirements with the family and child.

Will My Child Need a Blood Transfusion?

There is no arbitrary level of red blood cells or anemia that automatically indicates a transfusion. Each case is considered individually. When transfusion is likely, several options are available depending on local precedence. If the child is in good health and meets other criteria regarding body size and red blood cell mass, he or she may donate blood before elective surgery for transfusion during the operation. Another option would involve the anesthesiologist collecting a safe volume of blood before the beginning of surgery with the intent of transfusing the patient's own blood at completion of surgery. A third alternative, which is somewhat controversial, is to have directed donor blood available if it should be needed. Again, one should be familiar with the type of surgery that would justify one of these options (eg, posterior spinal fusion for scoliosis) and the local medical policies governing their use.

Overall, the incidence of transfusion-acquired infections seems to have declined during the last decade. This is attributed to the implementation of additional screening tests for infectious agents and aggressive donor screening. The dominant infectious agent transmitted is the non-A, non-B hepatitis virus, recently renamed hepatitis C. Although the risk of human immunodeficiency virus (HIV) transmission through blood that was screened as negative for HIV is still 1 in 150,000 to 250,000 units, there have been only 14 reported cases of transfusion-associated acquired immunodeficiency syndrome in the United States.
Techniques range from simple oral or nasal analgesics to more advanced techniques such as local anesthetics; the death rate was approximately 1.7 per 10,000 anesthetics. In children younger than 15 years, the incidence of cardiac arrest was 43 per 10,000, compared with 5 per 10,000 in children younger than 12 years (4.7 per 10,000) was 1.7 per 10,000 anesthetics. The incidence of cardiac arrest caused solely by anesthesia was approximately 1.7 per 10,000 anesthetics; the death rate was approximately 1.7 per 10,000 anesthetics. Minor complications such as sore throat, nausea, vomiting, croup, and oral trauma are frequently quoted to patients. Major complications would include dental trauma, postoperative anemia, major drug reaction, aspiration pneumonia, hypoxemia, arrhythmias, and cardiac arrest. In a 1985 study examining outcome data from a large general patient population, the incidence of cardiac arrest caused solely by anesthesia was approximately 1.7 per 10,000 anesthetics; the death rate was approximately 1 per 10,000 anesthetics. The incidence of cardiac arrest in children younger than 12 years (4.7 per 10,000) was three times greater than in adults (1.4 per 10,000). In a 1988 study, Tietz et al reported on the incidence of major anesthesia-related complications, defined as any fatal or life-threatening event or any incident resulting in severe sequelae that occurred during or within 24 hours of administration of anesthesia. They reported the incidence of such major complications to be 7 per 10,000 anesthetics administered and only 1 death in 40,000 anesthetics administered to children younger than 15 years. In children younger than 12 months, the incidence of major complications was 43 per 10,000, compared with 5 per 10,000 in older children. More serious complications are likely to occur in patients with predisposing conditions that compromise organ system function.

How Will My Child “Go to Sleep”?

Depending on the setting, the child, the procedure, and concurrent medical problems, there exist numerous modalities for treatment of postoperative pain. Techniques range from simple oral or rectal analgesics and/or wound infiltration with local anesthetics to patient-controlled analgesia to regional blocks with local anesthetics and/or opioids. Each has its own risks and benefits, which should be discussed. Some techniques require specially trained personnel to provide safe implementation and are not available at every hospital.

How Will My Child’s Pain Be Treated?

There are numerous techniques available to begin the induction of anesthesia. These include rectal, nasal, oral, inhalation, intravenous, and intramuscular administration of agents. Each has advantages and disadvantages. A given technique is chosen with the child’s safety foremost in mind. Various factors, including anesthesiologist experience, usual practice at the institution, and patient condition, enter into the determination of what will provide the smoothest and least traumatic induction for the child. Different approaches are used with good success and acceptance at different institutions. Many times, distraction techniques and a topically applied local anesthetic mixture of lidocaine and prilocaine (EMLA cream) are used when establishing intravenous access. Anesthesia masks are scented with a familiar fruit or candy before placement on the child’s face for a “breathe down” or inhalation induction.

How Are the Risks and Complications of Anesthesia?

Minor complications such as sore throat, nausea, vomiting, croup, and oral trauma are frequently quoted to patients. Major complications would include dental trauma, postoperative anemia, major drug reaction, aspiration pneumonia, hypoxemia, arrhythmias, and cardiac arrest. In a 1985 study examining outcome data from a large general patient population, the incidence of cardiac arrest caused solely by anesthesia was approximately 1.7 per 10,000 anesthetics; the death rate was approximately 1 per 10,000 anesthetics. The incidence of cardiac arrest caused solely by anesthesia was approximately 1.7 per 10,000 anesthetics; the death rate was approximately 1 per 10,000 anesthetics.14

SUMMARY

The preparation of a child who is about to undergo surgery or anesthesia involves the child’s family, primary care physician, anesthesiologist, surgeon, and, many times, other specialists. Communication among the individuals caring for the patient is paramount for the smoothest perioperative course. Established lines of communication permit the efficient and meaningful transfer of patient information and provide the most efficient means of informing the patient about necessary procedures. Familiarity with operating room and day surgery unit policies (eg, NPO guidelines, arrival times, and preoperative educational programs) helps alleviate patient and parent anxiety.

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Evaluation and Preparation of Pediatric Patients Undergoing Anesthesia: Section on Anesthesiology
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