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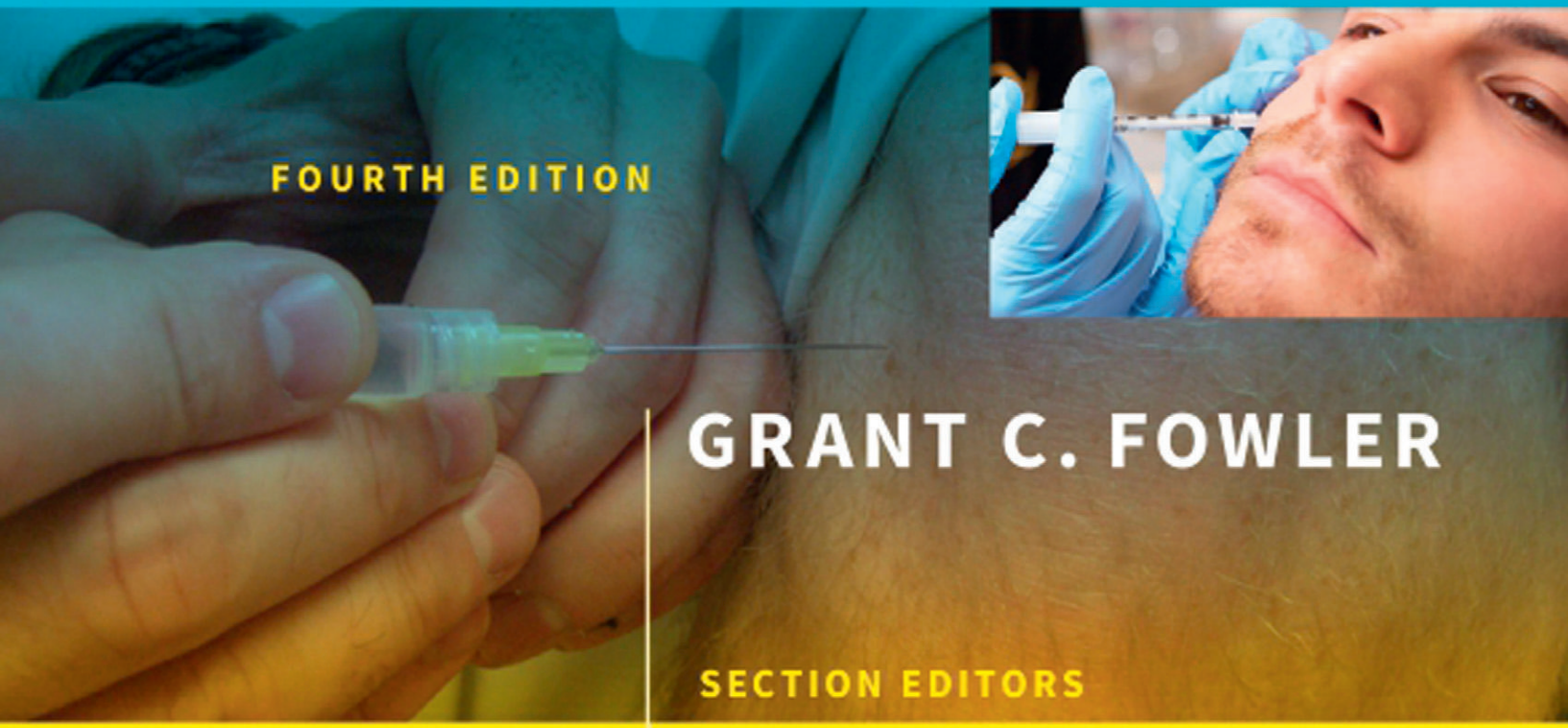
Procedures *for* Primary Care



FOURTH EDITION

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As they should have been, the first three editions were dedicated to our families, friends, and colleagues. They both inspired and tolerated us through this process, again and again. Likewise, this edition is dedicated to them.

Special thanks to the faculty, staff, and residents of two different Departments of Family and Community Medicine in Texas for both contributing to and being supportive of this edition.

This book is also dedicated to primary care clinicians who continue to practice "full-scope" family medicine. It is dedicated to those who continue to practice in our current healthcare system as it evolves further, even if we are sometimes just considered a "provider." Many of us now take care of patients in a patient-centered medical home, but our patients still need procedures and appreciate those provided by primary care clinicians. Performing such procedures not only remains a fun part of our practice, but it may also improve our metrics. My prediction persists that patient outcomes and satisfaction as well as healthcare systems will continue to be enhanced when as many procedures as possible are provided by primary care clinicians.

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PREFACE

The face of medicine has changed dramatically since the first edition of this text was published in 1994, and it continues to change. Electronic medical records (EMRs) have become the framework for most medical practices, especially those that are part of large group practices. And large group practices are becoming the norm, with two-thirds of primary care clinicians now employed. The Affordable Care Act almost succeeded in requiring everyone to have health insurance. But having insurance and being able to afford necessary or important procedures are two different things. Deductibles are higher than ever, so many patients are not able to afford procedures. Therefore, despite all the changes in healthcare, some things have not changed. Patients are still postponing procedures until they can afford them. The performace of procedures by primary care clinicians not only improves access, it also makes it more likely patients will get them and can afford them.

The vision of the primary care clinician "who can provide a breadth and continuity of commonly needed healthcare services for adults and children, who can deliver babies, manage simple fractures, counsel single parents, go to the hospital, maintain an office, and when all else fails, comfort the dying… who provides healthcare from the nursery to the nursing home, without taking the patient to the poorhouse along the way" as defined by Dr. Rodney in the foreword to the first edition still remains. However, attempts to reach this vision are being made in many different ways.

The patient-centered medical home (PCMH) has become mainstream and attempts to provide what is in this vision. PCMHs seem to offer what the primary care clinician aspired to do alone in the past (and still often does in rural settings). In the best PCMHs, the primary care clinician has become both the quarterback and the systems analyst. Levels of PCMH certification are based on measured metrics of quality. In this setting, primary care clinicians performing procedures still makes sense. One of the metrics that PCMHs must follow is the ability to track referrals; what better way to verify patient completion of a referral for a procedure than if a primary care clinician within the group is doing the procedure? Patient satisfaction is another metric; how better to keep the patient satisfied than to have his or her own clinician perform the procedure? What better way to improve your metrics on cancer screening than to be the one who performs this screening?

Direct primary care and concierge medicine are also rapidly evolving as an alternative model of care. The number of providers currently providing this type of care is rapidly increasing. Once again, what a great marketing opportunity: "Your personal care clinician will also perform your procedures"!

The feedback received on the first three editions of this text has been appreciated. New features in this edition include a section on Urgent Care Procedures. Many more primary care clinicians are practicing in this setting. It is also refreshing to note that surveys by the American Board of Family Medicine of recent residency program graduates have shown more interest in performing a wider breadth of procedures than has been seen in the last 20 years.

As an editor of this book over the last 26 years, I have noticed another recent phenomenon. Although the basic steps for many procedures may not have changed, the evidence regarding them has usually become much more robust. Consequently, this is by far the most evidence-based edition. This was the charge and challenge given to section editors: to update chapters where necessary, and if evidence is available regarding a procedure, make every effort to review it. Such evidence is also frequently listed in the Recommended Reading sections.

Another thing that has not changed over the years is the fact that our patients are very busy. They appreciate not having to take the time to go meet another clinician to have a procedure performed. In some cases, that would also mean a higher copayment. It still makes sense for primary care clinicians to perform procedures. A stigma also remains that the primary care clinician performing procedures not only offers one-stop shopping, but they may also perhaps be a better-trained clinician.

Although the problem is not new, public awareness of clinician burnout has been increasing. Part of my personal plan for preventing burnout is to perform and teach procedures. Perhaps other primary care clinicians occasionally need an escape from the mind-numbing process of data entry that EMRs sometimes necessitate. Although the advent of EMRs occurred at about the same time as burnout started being recognized, experts tell us that EMRs are not the cause. Regardless, performing procedures is fun, and procedure notes are usually much more amenable to the use of a template. And my computer monitor never gets between me and the patient when I'm performing a procedure. While I'm not sure of the evidence surrounding whether performing procedures prevents burnout, it seems like an excellent topic for someone to study. So this is a call for more studies!

While there have been many changes in medicine since the first edition, other things have not changed. No matter how complicated our systems become, or how busy we become, or how much technology we adopt, certain aspects of practice should always remain the same. The focus should be entirely upon the patient and family in front of us, especially at the time of the appointment or procedure. As mentioned in the Preface to a previous edition, in our search for the knowledge and expertise to perform the procedures presented in this text, we should never forget that we are first and foremost people who treat patients and their families, not just their symptoms. When it comes to procedures, our goal should always be to perform procedures as a way to prevent disease and to help people feel better and be healthier.

Grant C. Fowler, MD

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Thanks to Judith Fletcher for getting this edition started, to Dee Simpson and Carrie Stetz for getting it done, and to Sarah Barth for wrapping it up. Dee and Carrie, thanks for an enormous amount of proofreading and production. You both remained steadfast with the project; Dee throughout the project and Carrie with the page proofs at the end. Clinicians everywhere are grateful for your attention to detail and dedication.

A special acknowledgment goes to Dr. Jack Pfenninger, who has officially retired and sold his practice that was dedicated to office procedures. This book was your idea. We missed you with this edition, the first edition in which you were not an editor, but congratulations! That being said, none of us believes you will give up tilting at windmills.

FOREWORD

The specialty of family medicine in America turned 50 years old in 2019. Much has been accomplished over the past 5 decades. Residencies have been established in more than 450 hospitals, and departments of family medicine exist in most American medical schools. Family medicine has successful ongoing collaborations with general internal medicine, general pediatrics, and with academic programs in nursing, pharmacy, the mental health professions, and physician assistant training. The scholarly work of family medicine faculty members has laid the groundwork for new approaches to clinical care and education in all the primary care disciplines. First published in 1994, *Procedures for Primary Care* is perhaps the best example of such scholarship. It is therefore fitting that a new edition appears as the specialty celebrates its birthday. Through three previous editions, this book has become a staple in the offices of primary care providers around the world. Now in its fourth edition, it includes an encyclopedic catalog of clinical procedures in 235 chapters offering both specific instructions on the best techniques for each procedure and information for patients receiving such care.

Family medicine has undergone major changes since the first edition was published 26 years ago. We have adopted the model of team-based care in the patient-centered medical home. We have worked to fully integrate behavior health into the primary care system. We have adopted electronic health records and can now track population health in new and powerful ways. But the core value of primary care is still based on trusting relationships with patients (continuity of care) and on our ability to deliver a broad scope of services to our communities (comprehensive care). For our care model to work, patients must be able to trust their family physicians to competently care for any problem that is common in the community. Yet there is growing evidence that the very comprehensiveness that makes primary care effective is eroding; referral rates to specialists are rising, and fewer family physicians are delivering the full scope of care intended by our founders. Performing common procedures in the primary care setting lowers the referral rate to specialty care, improves patient confidence and trust in our care, and keeps care located in the community where it can be most efficiently provided. Despite all the changes going on around us, performing common clinical procedures competently and safely remains a critical contributor to both continuity and comprehensiveness. As always, the challenge lies in the very broad scope of services required for successful primary care. This is why an up-to-date and comprehensive reference text for primary care procedures is so important.

Over the course of three previous editions, *Procedures for Primary Care* has also proven useful in emergency medicine and hospital care. The fourth edition now includes a specific section devoted to urgent care procedures. As a result, copies of this book can now be found in settings well beyond primary care offices. Nevertheless, most of the chapter authors continue to be family physicians. Their work stands as a testament to the importance of comprehensiveness in primary care and exemplifies the contributions of family medicine to improving clinical care and medical education in general. Thus, this book is both clinically and historically important. *Procedures for Primary Care* now fills an essential niche in American medicine. Everyone in the primary care community owes a debt of gratitude to the authors, editors, and publisher of this important book.

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FOREWORD TO THE THIRD EDITION

There are two sides to the complete primary care physician. One side is the compassionate listener, a person who can heal with words. The other side is the talented caregiver who can provide and apply medical science, including necessary or desired procedures for patients. People need people for good health, and those who have a complete primary care physician who knows them and treats them are among the luckiest people in the world. The complete primary care physician is a precious resource that has been endangered but is making a comeback.

Pfenninger and Fowler's Procedures for Primary Care is the bible for the laying on of hands in primary care practice. The first edition in 1994 sold over 40,000 copies and became a fixture in the library of every residency program. It is the one book that is worn and well-used. The second edition in 2003 had 82 new chapters and cemented the book as a must-have in every primary care office. The third edition expands this classic text to an amazing 234 chapters with two new sections, Aesthetic Medicine and Hospitalist Procedures.

The scope of primary care is expanding. After years of decline because of "turf wars" with specialists, health systems are appreciating more than ever that having multitalented primary care physicians is the key to efficient and high-quality healthcare delivery. Comprehensiveness is now back in style for primary care with the Patient-Centered Medical Home as the provider and coordinator of all healthcare services. This is not the "gatekeeping" of managed care but rather a "place" where patients share an information system with their personal physician and have all their services coordinated. The more the primary care physician team can do, the better for everyone.

I am fortunate to be "walking the talk" of the Patient-Centered Medical Home model. In 2009, I was asked to develop a new primary care practice network in a heavily doctored area of southern California. Building off the practice of one physician, we will have 9 offices and 26 physicians in early 2011. We are starting residency programs in family medicine and internal medicine. All practices qualify as advanced medical homes. We have established a variety of "procedure clinics" among our group, performing a wide variety of dermatologic procedures and aesthetics. We have expertise among us in sports medicine. We are developing our own hospitalist service. While no primary care physician will do all the procedures described in this book, among us we will do almost all of them. We will train a new generation of primary care physicians in as many procedures as time and interest allows. *Procedures for Primary Care* is our indispensable guide.

There is a renaissance underway in primary care. The internet and information technology change how we do most everything, and primary care is no exception. Patients now have access to a world of information for free, including healthcare and their medical records. Primary care physicians have become "information managers" for patients and access to communication online has become continuous. In this new world of information, communication, and continuous care, what patients need and want is shared decision making. For patients, an "I can do that for you" from their primary care physician is usually a welcome relief. The world of specialists is often confusing and usually very expensive. Good primary care exudes value, the combination of quality and efficiency, so needed and welcomed in healthcare today.

Knowledge is power and knowledge is abundantly available in *Procedures for Primary Care*. Jack Pfenninger and Grant Fowler have assembled a phenomenal group of talented authors who all "walk the talk" of their chapters. Need to remove a fishhook? Need to remove a ring from a swollen finger? Remove isolated hairs for good? Apply an Unna boot? Repair an earlobe? This book has procedures for them all, of course, and these examples are only a small slice of what is here. If you want to venture into Botox treatment or provide stress echocardiograms, this book will tell you how. We often go to workshops to learn new procedures, but what is helpful to keep doing them is a handy reference to remind us of all the elements of the procedure.

Patient safety requires that we have a checklist for each procedure and not just rely on what we and our staff remember at the time. This book has all the checklists. I imagine a thousand times a day physicians and office staffs somewhere are reviewing a chapter in this book before going into the treatment room. Copies of these checklists should become part of your office procedure manual.

I am certain that this will not be the last edition of *Procedures for Primary Care*. This resource is simply too valuable not to have, and access to it needs to be in print in every office. With this edition, the patient education sheets have been moved online to make downloading and printing easier and more convenient. I imagine synergy with the internet will grow over time as it has with other classic textbooks. For now, having a readily available copy of *Procedures for Primary Care* will be at the top of your office resources. Use it often to keep your quality of care high and your scope of practice broad for the benefit of your patients.

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FOREWORD TO THE SECOND EDITION

As a comprehensive guide to performing medical and surgical procedures in the office, hospital, or emergency department, *Pfenninger and Fowler's Procedures for Primary Care* might be considered an antidote to the evils that originated from Pandora's box. According to Greek mythology, Pandora (whose name means "rich in gifts") found a buried box and impulsively removed its lid. Out of the box, scattering in every direction, came disease, death, and all the other evils that afflict humankind. Like Eve in the Christian scriptures, Pandora introduced mortality into our world. However, her box also contained an antidote—hope—and she closed the lid just in time to prevent this quality from escaping.

In combating the myriad diseases that Pandora supposedly unleashed, primary care clinicians have long been powerful agents for hope and healing. Because of advances in treatment options, including minimally invasive outpatient surgical techniques, many procedures that previously would have necessitated hospitalization or consultation now can be performed by primary care clinicians in the office, hospital, or emergency room. This arrangement allows continuity of care, hopefully provides excellent patient education, and, by moving some procedures out of the hospital, may offer significant economic advantages. However, as their role expands, these clinicians must continue to use sound judgment and keep the patient's welfare as the uppermost priority. They should avoid procedures beyond their expertise; they should avoid procedures that might necessitate repetition; and they should avoid procedures that might cause them medicolegal problems.

Like Pandora, *Pfenninger and Fowler's Procedures for Primary Care* is rich in gifts, but these are of the life-affirming kind. More than 200 chapters provide up-to-date information for a continually evolving specialty. The book includes practical, step-by-step instructions for performing an extensive array of medical and surgical procedures, as illustrated by line drawings and clear photographs. It also covers indications and contraindications, equipment and suppliers, complications, billing codes, and other practical topics. In the literature for primary care clinicians, few other books cover such a wide range of topics. Indeed, I know of no other volume that is likely to be more useful to its intended audience.

Some readers may wonder why this foreword is being written by a cardiovascular surgeon and not by a primary care clinician. Perhaps they will allow heart disease to serve as an example for many other diseases. Primary care clinicians are at the leading edge of the battle against many diseases—not only in treatment but also in prevention. Regarding heart disease, their advice is often the deciding factor in convincing patients to make positive changes with respect to fat intake, physical activity, cigarette smoking, and other lifestyle factors. An example from the recent literature supports this premise: in a study involving patients with coronary artery disease at Creighton University, recommendations from primary care clinicians concerning the assessment of lipid profiles and use of statin therapy significantly reduced the number of adverse cardiovascular outcomes. As the average age of the population continues to increase and congestive heart failure becomes increasingly prevalent, primary care clinicians can be expected to play an even greater role in diagnosing and treating this disorder. If primary care clinicians can do this with heart disease, it is my hope that they can use their abilities in many other areas of medicine.

The book also contains patient education handouts. When primary care clinicians perform a procedure, they must know the disease well. In so doing, they also have a golden opportunity to teach some prevention principles. I hope that they will never miss the opportunity to treat the whole patient and potentially change the course of the disease by educating the patient before, during, and after performing the procedure.

In conclusion, I congratulate Drs. Pfenninger and Fowler on producing such an excellent volume. It should help improve the quality of care in many aspects of medical practice, and I highly recommend it for every primary care clinician and trainee. There are some who consider me a pioneer in heart disease; I hope that this book encourages medical pioneers everywhere to prevent and treat early the diseases that Pandora supposedly released.

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FOREWORD TO THE FIRST EDITION

In 1930, more than 80% of the physicians in the United States were general family doctors, providing comprehensive health care at a reasonable cost. By 1980, the self-reported percentage of family doctors in the United States was 15%. Along with this trend of dwindling numbers has been a gradual decline of diagnostic and therapeutic skills held by those physicians who do practice general family medicine.

One definition of a generalist physician (formerly a general practitioner) is a family physician who can provide a breadth and continuity of commonly needed healthcare services. These physicians care for children, deliver babies, manage simple fractures, counsel single parents, go to the hospital, maintain an office, and, when all else fails, comfort the dying. Their goal is to provide health care from the nursery to the nursing home, without taking the patient to the poor house along the way

Today, of the 625,000 physicians in the United States, fewer than 10% comprehensively wield the clinical skills needed to provide such care. The headlong rush to subspecialize in medicine has left family physicians in the minority. Still, they are an important minority whose number is now growing in response to the projected needs of the twenty-first century American healthcare system.

Since 1983, a group of family physicians, supported by the American Academy of Family Physicians (AAFP), has constructed a series of demonstration projects to propagate diagnostic and therapeutic skills in family medicine. Many of the procedural pioneers in family practice have quietly and unselfishly contributed their professional energies to the resuscitation of full-service family practice within a medical education system gone far, far astray. This book stands as a contribution to that effort. Although some may view the teaching and learning of clinical skills as "proceduralism," the skills that are depicted in this book represent the desire of physicians to remain clinically excellent. No amount of psychosocial expertise can overcome the credibility lost when a physician cannot perform basic clinical services on behalf of his or her patient.

Recently a prominent dean of a well-known medical school asked me why the residency programs at my institution, the University of Tennessee, persisted in reaching a comprehensive set of procedural clinical skills when, in his opinion, managed care organizations and health maintenance organizations would effectively amputate these skills from the day-to-day practice of family physicians. I disagree with this vision of the future, but it is true that some family physicians voluntarily relinquish many of the clinical skills described in this book. It is my hope that the skills described in its pages will become required curriculum, not only for residents, but, particularly, for faculty. One of the major challenges for the success of this book (and the specialty of family practice) is the development of accountability in a healthcare system that has become overly fragmented, costly, and inaccessible.

Are these skills needed? During the past 20 years, family physicians have been manipulated, exploited, and oppressed in a variety of ways that makes study of their actual needs very complex. For example, a lack of reported interest in obstetrical care cannot be used to justify the tremendous void that exists in women's healthcare as provided by family physicians. Residents are not likely to acquire clinical skills that family physician faculty members cannot themselves demonstrate in their positions as role models. A lack of procedural skill among family practice faculty and practitioners is particularly troubling in rural and underserved communities. These communities cannot afford platoons of various subspecialized physicians.

Although excellent healthcare is available from a combination of obstetricians, pediatricians, and internists, a well-trained, comprehensive-care family physician should be able to deliver continuing healthcare unrestricted by age, sex, organ system, and pregnancy. The physician should be skilled in many of the procedures described here to screen for, prevent, and treat common disease entities. If family practice simply becomes synonymous with "generic primary care," there will be very little need for many of the skills described in this book. My compliments to the editors and the authors for executing a labor of love in an outstanding fashion. They have chosen the road less traveled.

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SECTION I

Anesthesia

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CHAPTER 1

Procedural Sedation and Analgesia

Sylvana Guidotti

Procedural sedation and analgesia (PSA) is the clinical practice of using pharmacologic agents to achieve a measurable level of sedation while performing typically painful or anxiety-provoking procedures. The term *conscious sedation* is no longer used because it describes neither the intent nor the outcome of the process. PSA allows the nonanesthesiologist to perform selected procedures in a safe and controlled setting.

The Joint Commission (TJC) has produced sedation guidelines to describe and define the spectrum of PSA. More importantly, the American Society of Anesthesiologists (ASA) and the American College of Emergency Physicians (ACEP) have published guidelines for PSA by nonanesthesiologists and emergency physicians, respectively. As defined by the ASA, PSA is a continuum from minimal sedation/analgesia to general anesthesia.

Minimal sedation occurs when the patient continues to respond normally to verbal commands without cardiopulmonary functions being affected. *Moderate sedation* is a state of depressed consciousness where the patient responds appropriately to verbal command with or without light tactile stimuli. *Dissociative sedation* should be considered a form of moderate sedation that occurs when a dissociative pharmacologic agent produces a trancelike state. The result is analgesia and amnesia while protective airway reflexes and cardiovascular stability are maintained. *Deep sedation* causes a depression of consciousness in which the patient is not easily arousable but responds purposefully with repeated or painful stimuli. At this level, the patient may require assistance in maintaining airway and ventilation. *General anesthesia* is at the end of the spectrum; consciousness is lost and the patient is unarousable to any stimuli. The patient requires ventilatory assistance, and cardiovascular function may be affected or impaired.

For coding purposes, the American Medical Association CPT coding manual describes "moderate (conscious) sedation" as a drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is maintained. It does not include minimal sedation (anxiolysis), deep sedation, or monitored anesthesia care (Table 1.1).

PSA is composed of three components. First is the *process of sedation*, which requires a thorough knowledge of the agents being administered. Next is the *intended procedure* to be performed. Finally, there are the *unpredictable side effects and untoward reactions* to the sedating medications, which can occur during or in the recovery phase of the procedure.

The clinician should be familiar with all of the appropriate monitoring and rescue equipment. A suitably trained provider should assist with the sedation. All individuals who participate in the care of the patient undergoing PSA must demonstrate ongoing clinical competency and be privileged for the procedure if they will be performing it in a hospital setting.

Indications

As nonanesthesiologist clinicians become more comfortable with PSA, the roster of appropriate procedures where these agents are beneficial continues to expand. The list includes, but is not limited to, the following:

- Anal procedures
- Biopsy procedures
- Bone marrow aspiration or biopsy
- Bronchoscopy
- Cardioversion (electrical or chemical)
- Dental/oral surgical procedures
- Endometrial biopsy
- Essure contraceptive placement
- Fracture reductions/care
- Gastrointestinal endoscopy
- Hysterosalpingography
- Lumbar puncture
- Magnetic resonance imaging/computed tomography scans/invasive radiographic procedures
- Office dilation and curettage/vacuum aspiration
- Orthopedic procedures
- Phlebectomy
- Plastic/cosmetic/laser procedures
- Wound repair/care, including burns; large excisions

PSA can be used in conjunction with and as a supplement to digital blocks, hematoma blocks, or regional nerve blocks, as well as topical anesthetic agents. These modalities may obviate the need for deeper levels of sedation. Other distractions for the patient such as music or videos are useful adjuncts.

Contraindications

Elective procedures on pregnant patients should be deferred until after delivery. Patients with severe unstable systemic disease and patients with potentially unstable airways should be directed to a higher level of care. The ASA classification of systemic disease is designed to guide the clinician as to which patients are appropriate candidates for PSA (Table 1.2).

Class II patients include those with well-controlled hypertension, controlled non–insulin-dependent diabetes, and minimal cardiac or respiratory disease. Class III patients include those with insulin-dependent diabetes mellitus, poorly controlled hypertension, significant cardiac or respiratory disease, and significant renal or hepatic disease. Based on individual experience and skill in

TABLE 1.1 Operational Definitions and Characterizations of Levels of Sedation: Analgesia

Sedation Score	Level of Sedation	Level of Consciousness	Response			Ventilation, Oxygenation
			Verbal	Tactile	Patency	
0	None	Fully aware of self and surroundings	P	P	P	P
I	Minimal	Mostly aware of self and surroundings but sedate	P–L	P	P	P
2	Moderate	Slightly aware of self and surroundings, usually somnolent, arouses easily with stimuli	L–A	P–L	P–L*	P–L*
3	Deep†	Not aware of self or surroundings, little arousal with stimuli	A	L (to pain)	L–A	L
4	General anesthesia	Unconscious, no arousal with painful stimuli	A	A (to pain)	L–A	L–A

A, Absent, inadequate; *L*, limited, partial, mildly abnormal; *P*, present, adequate, or normal.
*May need to supplement oxygen to maintain oxygen saturation (SaO_2).
†Deep sedation may be indistinguishable from general anesthesia and carries all the same risks.

TABLE 1.2 American Society of Anesthesiologists Physical Status Classification

Classification	Sedation Risk
Class I: normal healthy patient	Minimal
Class II: mild systemic disease without physical limitation	Low
Class III: severe systemic disease with functional limitations	Intermediate
Class IV: severe systemic disease that is a constant threat to life	High
Class V: moribund patient who may not survive without procedure	Extremely high

ASA, American Society of Anesthesiologists.

providing sedation, practitioners may decide to limit the amount of patient risk they are willing to accept, using the ASA guidelines.

In general, the nonanesthesiologist clinician who provides PSA in the private office setting should do so on patients with class II status or less. For hospital-based procedures outside the operating room, PSA may be performed on patients up to and including class III status.

The ASA has set forth *preprocedure fasting guidelines* for scheduled elective cases. However, in separate recommendations for PSA, the ASA states, "The literature does not provide sufficient evidence to test the hypothesis that preprocedure fasting results in a decreased incidence of adverse outcomes in patients undergoing either moderate or deep sedation." The current guidelines are the result of consensus, rather than being evidence based, with respect to the risk of aspiration. *The recommendations are 6 hours for solids, cow's milk, and infant formula; 4 hours for breast milk; and 2 hours for clear liquids*. ACEP recognizes that there are certain emergent situations in which the benefits of PSA at any sedation depth outweigh the potential risks. In all other circumstances, it would be best to strictly adhere to the fasting guidelines. Thus, if a patient has not followed the aforementioned fasting guidelines, it would be best to postpone the procedure or to just not use significant PSA.

EQUIPMENT

- A single unit with blood pressure and electrocardiographic measurements, variable-pitch beep pulse oximeter, and recording device is the ideal monitor for PSA. Individual units are acceptable but require repeated manual recordings of the readings on the patient's chart.
- Angiocatheter for intravenous (IV) access (at least 20 gauge), IV solution, and stand.

Fig. 1.1 Defibrillator. (Courtesy Zoll Medical Corp., Chelmsford, MA.)

- Oxygen source.
- Medications for sedation and analgesia.
- Reversal medications.
- Diphenhydramine and epinephrine to be used in the event of severe allergic reactions.
- Crash cart or Banyan kit with equipment and medications for basic and advanced cardiac life support (ACLS; see Chapter 212).
- Suction device.
- Defibrillator (Fig. 1.1).

Although it is not a requirement for class I patients, the *application of oxygen* by nasal cannula should be used for every patient undergoing PSA because each patient has a unique and unpredictable response to the medications. *Capnometry* is another, more sensitive measurement of ventilatory status and is being used frequently as part of PSA monitoring. As a measure of exhaled carbon dioxide, end-tidal CO_2 may detect hypoventilation before the development of oxygen desaturation.

PERSONNEL

At least two providers must be involved in PSA. The clinician who is performing the procedure is also ordering the medications. The assistant is typically a registered nurse who has fulfilled all of the requirements to administer PSA drugs, monitor the patient during the procedure and recovery phase, and participate in any needed resuscitations.

There should be a well-defined response for any cardiopulmonary emergency that results from PSA. Most hospitals have organized a "code team" to respond to such situations. In the nonhospital setting, the clinician should be able to manage the emergency until emergency medical services personnel arrive for transport to a hospital.

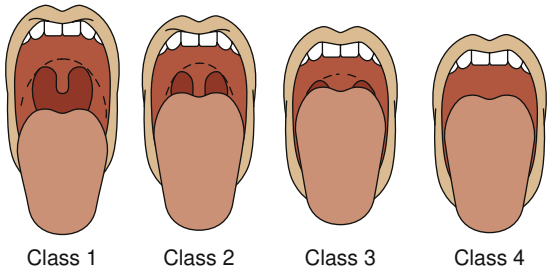

Fig. 1.2 Mallampati classification relates tongue size to pharyngeal size. It is based on the pharyngeal structures that are visible. *Class 1*: Visualization of the soft palate, fauces, uvula, anterior and posterior pillars. *Class 2*: Visualization of the soft palate, fauces, and uvula. *Class 3*: Visualization of the soft palate and the base of the uvula. *Class 4*: Soft palate not visible at all. (Modified from Mallampati SR, Gatt SP, Gugino LD, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. *Can J Anaesth*. 1985;32: 429–434.)

TABLE 1.3 Mallampati Classification

Class I	Full view of soft palate, fauces, uvula, pillars, tonsils
Class II	Visible hard and soft palate, fauces, upper portion of tonsils, and uvula
Class III	Visible hard and soft palate, base of uvula
Class IV	Only hard palate is visible

Preprocedure Patient Assessment

Every patient who undergoes PSA should have a *complete history and physical examination* before the procedure. Included in the documentation are pertinent medical history, current medications, allergies (problems with sedative or analgesics), and review of systems (snoring or obstructive sleep apnea). It should be determined whether there is a history of any past problems with anesthesia or a history of drug or alcohol abuse or dependence. The physical examination should focus on assessment of the airway and cardiovascular system. Anatomic variants (macroglossia, micrognathia) and presence of a beard, dentures, or a short, arthritic neck should be noted. Direct evaluation of the patient's open mouth using the *Mallampati classification* measures how much the tongue obscures the uvula and soft palate (Fig. 1.2 and Table 1.3). Obtain and document an *informed consent* from the patient for both PSA and the procedure. Explain the sedation process, potential for failure, and adverse effects, as well as alternatives to the procedure and the consequences of not providing sedation.

Preprocedure Patient Preparation

- Reconfirm the initial assessment and the patient's ASA classification.
- Document the fasting time.
- Determine prior history of drug or alcohol abuse or dependence.
- Determine prior history of past problems with anesthesia.
- Check a pregnancy test on age-appropriate women.
- Make certain there is an adult to escort the patient home.
- Ask the patient to void, dress in a gown, and recline on the procedure bed.
- Secure the IV line and ensure it is functioning.
- Apply blood pressure cuff, cardiac monitor, and pulse oximeter and document baseline vitals, including room air oxygen saturation (SaO_2).
- Ensure emergency resuscitation equipment and medications are functional and at the ready.
- Use a PSA monitoring flow sheet to record preprocedure, intraprocedure, and postprocedure data. Document start and completion times and medications and dosages administered, as well as the level of sedation achieved throughout the procedure (see flow sheets available at www.expertconsult.com).
- The practice of premedicating the patient with histamine type 2 blockers or proton pump inhibitors is no longer recommended because of the lack of evidence with regard to the efficacy of these drugs to diminish gastric acid secretion and subsequent risk of aspiration.
- Before sedating the patient, take a "time out" to once again identify the patient, the intended procedure, and the site. Once the procedure has started, encourage the patient to tell the operator about any unusual discomfort, shortness of breath, chest pressure, or itching.

Technique

1. Position the patient as comfortably as possible for the procedure, using warm blankets and placing pillows under the head or knees.
2. Use the single dose of medication that will provide a maximum level of sedation required to perform the procedure. Multiple small doses create discomfort for the patient and may culminate in oversedation. For painful procedures, begin IV administrations with a short-acting narcotic. For painless but anxiety-producing procedures, place more emphasis on anxiolysis. Maintain verbal contact with the patient. Observe the patient for slurred speech, droopy eyelids, and calm affect. The patient should stir to verbal commands and be able to follow them. Remember that the effects should start within several minutes but may not peak for up to 7 minutes.
3. Begin the procedure once the patient has achieved the desired depth of sedation.
4. If the patient is not sedated adequately after a modest dose of narcotic, administer a small dose of a short-acting benzodiazepine and continue to observe for effects. Recall the synergistic efforts of these drugs.
5. Record vital signs every 5 minutes. The assistant should remain at the patient's bedside throughout the procedure to observe the response to sedation and to respond to any monitor alarms. Monitor the patient continually for head position, level of consciousness, airway patency, and adequacy of respiration and oxygenation. Observation of ventilation is essential, especially when using supplemental oxygen, which will delay the detection of apnea by pulse oximetry.
6. Naloxone and flumazenil should be at the bedside in the event any reversal is required.
7. The depth of sedation should be assessed at frequent intervals during the procedure. *If the sedation is too light*, the patient may express displeasure or experience discomfort, as well as develop tachycardia or hypertension. *If sedation is too deep*, the patient may develop periods of apnea; the SaO_2 will decrease and trigger the monitor alarm. In addition, if side-stream end-tidal CO_2 is used (capnography), the earliest sign of respiratory compromise would be a steady increase of the end-tidal CO_2 to greater than 40 mm Hg. Finally, the patient's Aldrete score (see flow sheet available at www.expertconsult.com) will decrease if sedation is too deep. If at any time during the procedure there is a change in or deterioration of the patient's condition, either suspend or abort the procedure, assess the patient, and begin any resuscitation.

EDITOR'S NOTE: Although two randomized controlled trials (Deitch, Lightdale) demonstrated the use of capnography during procedural sedation decreased the incidence of hypoxic events, a recent Cochrane systematic review (Wall, 2017) found a lack of convincing evidence that adding capnography to standard monitoring for PSA in the emergency department would reduce the rate of clinically significant adverse events.

TABLE 1.4 Commonly Used Medications for Procedural Sedation and Analgesia

Medication	Class	Description	Initial IV Dose	Repeat Dose	Minimum Interval
Etomidate (Amidate)	Sedative-hypnotic	Rapid onset Short duration	0.1 mg/kg	0.1 mg/kg	5 min
Fentanyl (Sublimaze)	Opiate	Short acting	1 μgm/kg, up to 100 μg	25–50 μg	5 min
Flumazenil (Romazicon)	Benzodiazepine antagonist	Reversal agent for benzodiazepine	0.2 mg	0.2 mg, up to 1 mg total	1 min
Midazolam (Versed)	Benzodiazepine	Short acting Sedation/amnesia	1–2 mg	0.5–1 mg, up to 5 mg	5 min
Methohexital (Brevital)	Ultra–short-acting barbiturate	Nonanalgesic amnesia	0.75–1 mg/kg	0.5 mg/kg	2 min
Naloxone (Narcan)	Opiate antagonist	Reversal agent for opiate	0.2–0.4 mg	0.2 mg	2–3 min
Propofol (Diprivan)	Sedative-hypnotic	Rapid onset	1 mg/kg	0.5 mg/kg	3–5 min
Atropine	Anticholinergic Antiarrhythmic	Treatment of symptomatic bradycardia; decrease secretions	0.4 mg	0.4 mg, 3 mg max	3–5 min
Diphenhydramine (Benadryl)	Antihistamine Anticholinergic	Treatment of anaphylaxis; sedative; antiemetic	25 mg	25 mg	5–10 min
Metoclopramide (Reglan)	Central and peripheral dopamine antagonist	Antiemetic	10 mg	—	—
Ondansetron (Zofran)	Serotonin (5-HT_3) receptor antagonist	Antiemetic	4 mg	4 mg, 16 mg max	5–10 min

MEDICATIONS

There are several medications in the armamentarium of PSA. The clinician must understand the pharmacology of these drugs and the appropriate settings in which to use them.

A short-acting analgesic should be used at the onset. Fentanyl has a very good safety profile with a rapid onset and short duration of action. It does not cause the extent of cardiorespiratory depression that is typical of other opioids. However, its side effects are magnified with benzodiazepines (Table 1.4).

If anxiolysis is the goal of PSA, fentanyl combined with midazolam provides a minimal level of sedation that is ideal for such procedures as cardioversion, endoscopy, lumbar puncture, and certain wound repairs. *When moderate sedation* is desired for particularly painful procedures, fentanyl can be used with etomidate to create relaxation for closed reductions of joint dislocations or fractures. Propofol can be used for moderate or deep sedation. It has no analgesic properties and should be used with fentanyl. It is safest to deliver propofol as a continuous infusion that can be discontinued if any adverse reaction occurs. At low doses, methohexital produces a state of unconsciousness while preserving protective airway reflexes. It is purely an amnestic agent, and careful use with opioids is advised. Hypotension and histamine release are significant side effects.

Ketamine is a dissociative agent that has a long history of use for pediatric PSA. The data supporting the use of ketamine in adults are very few, owing to the increased incidence of hallucinations during emergence from the drug.

COMPLICATIONS

Several factors are associated with adverse outcomes during PSA. In addition to the known effects of the drugs themselves, there are patient factors, inadequate preprocedural evaluation, drug-drug interactions, drug dosing errors, and inconsistent monitoring and observation.

Respiratory depression is the most common and profound adverse effect. All of the drugs used inhibit respiratory drive to some degree. The synergistic effects that occur when the drugs are combined can magnify the inhibition of the respiratory system. If the SaO_2 decreases to less than 90%, the procedure should be suspended and the patient evaluated. In addition, *chest wall and glottic rigidity* are catastrophic side effects of fentanyl that can occur when a high dose of the drug is injected rapidly. Under these circumstances the patient may require paralysis and mechanical ventilation until the symptoms resolve.

Sympathetic output from the central nervous system is similarly suppressed by all of the PSA drugs and can result in *bradycardia* and *hypotension*. Furthermore, a preponderance of patients take β-adrenergic blockers and calcium channel blockers, which increase the risk for *dysrhythmias* and cardiovascular collapse during PSA. Atropine *0.4 mg* IV push is used to treat symptomatic bradycardia (i.e., bradycardia associated with hypotension or heart block).

Nausea and vomiting are usually due to opioids. Preventing unwanted gastrointestinal side effects is important when the patient's sensorium is depressed, because emesis could lead to aspiration. Noxious gastrointestinal symptoms also make for an unpleasant experience for the patient. Ondansetron (Zofran) 4 to 8 mg IV is an excellent antiemetic.

Should the patient experience any *itching* or if *urticaria* becomes apparent (allergic reactions), diphenhydramine 25 mg IV should be administered. Auscultate the lungs for wheezing and check vital signs. Inhaled bronchodilators, IV corticosteroids, and subcutaneous epinephrine are appropriate for the management of allergic reactions and anaphylaxis.

In rare instances, *paradoxic reactions* to benzodiazepines can occur. Malignant hyperthermia must also be kept in mind as a potential complication.

POSTPROCEDURE RECOVERY AND PATIENT EDUCATION

Recovery should occur in a place where there is adequate cardiopulmonary monitoring and trained personnel for direct observation because the patient continues to be at risk for development of drug-related complications. If reversal agents are administered, continuous observation is required until sufficient time has elapsed for the last dose to wear off, thus avoiding resedation. The *Aldrete score* uses five criteria to determine a level at which it is safe to discharge the patient. The parameters include a measure of blood pressure and SaO_2 and an evaluation of the patient's mental status, airway patency, and motor function. (See flow sheet available at www.expertconsult.com.)

The patient's escort should be given both verbal and written instructions that include postprocedure activities, diet, and medications. Give the patient the following advice:

- Do not drive a car or operate hazardous equipment until the next day.
- Do not make important decisions or sign legal documents for 24 hours.

- Do not take medications, unless your clinician has prescribed them specifically, for the next 24 hours.
- Avoid alcohol, sedatives, and other depressant drugs for 24 hours.
- Notify your health care provider of pain, severe nausea, difficulty breathing, difficulty voiding, bleeding, or other new symptoms.

Patient Education Guides

See patient education and consent forms and PSA monitoring flow sheets available at www.expertconsult.com.

CPT/Billing Codes

See the CPT definition for moderate sedation discussed earlier.

36000 Introduction of needle or intracatheter, vein
96379 IV injection (use in conjunction with J codes for drugs)
94760 Noninvasive ear or pulse oximetry for oxygen saturation
94760 Noninvasive single interpretation
94761 Noninvasive, multiple interpretations
99152 Sedation services provided by the same physician performing the diagnostic or therapeutic service that the sedation supports requiring the presence of an independent observer including monitoring of cardiorespiratory function (pulse oximetry, electrocardiogram, and blood pressure), age 5 years or older, initial 15 minutes. When providing moderate sedation, the following services are included and *not* reported separately:

- Assessment of the patient (not included in intraservice time)
- Establishment of IV access and fluids to maintain patency, when performed
- Administration of agent(s)
- Maintenance of sedation
- Monitoring of SaO_2, heart rate, and blood pressure
- Recovery (not included in intraservice time)

Intraservice time starts with the administration of the sedation agent(s), requires continuous face-to-face attendance, and ends at the conclusion of personal contact by the physician providing the sedation.

99153 Each additional 15 minutes of intraservice time
99156 Moderate sedation services provided by a physician other than professional performing the procedure, first 15 minutes, age 5 years or older
99157 Each additional 15 minutes

Suppliers

(See contact information available at www.expertconsult.com.)

Banyan kits
Banyan International Corp.
Capnometry monitors
Nellcor Coviden Medtronic
Heartstream semiautomatic defibrillator
Philips Medical Systems
Vital signs monitors
Welch Allyn

RECOMMENDED READING

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CHAPTER 2

PEDIATRIC SEDATION AND ANALGESIA

Paul W. Davis

Over the past 2 decades, various professional medical societies and hospital associations have readdressed the challenging issue of sedation and pain control in children, with the goal of developing and updating multidisciplinary guidelines. These societies have included the American Academy of Pediatrics (AAP), the American Society of Anesthesiologists (ASA), and The Joint Commission (TJC). Their recommendations have usually relied on expert opinion and consensus, and some openly advised that all pediatric sedation be performed under the direction of pediatric subspecialists. We and the American College of Emergency Physicians (ACEP) respectfully disagree with the assertion that only pediatricians and anesthesiologists can safely and effectively administer these medications.

The administration of medications for analgesia and moderate or deep sedation was previously termed *conscious sedation*. However, because these medications actually do alter a patient's level of consciousness and perception of pain, the phrase is inaccurate and is now rarely used.

HISTORICAL PERSPECTIVE ON UNDERTREATMENT OF PAIN

Historically, the management of pain and anxiety in the pediatric population outside of the operating room has been inadequate. Indeed, several studies have suggested that inattention to pain may be more prevalent for pediatric procedural care delivered outside of children's hospitals. Nevertheless, any clinician who has performed even minor procedures for infants and children appreciates the value of being able to safely and predictably sedate them. Aside from the psychological shock and trauma imposed on infants and children because of a limited understanding of the purpose for a procedure, developmental responses to pain vary by age and can thwart the most well-meaning clinician's efforts to complete a needed procedure.

At least six factors have been identified as contributing to the undertreatment of pain and anxiety in the pediatric population: (1) lack of familiarity with the use of sedative agents; (2) the erroneous conception that newborns and infants do not feel pain; (3) the incorrect belief that children have a very short-term recollection of painful events; (4) the fear of adverse effects of sedatives and analgesics; (5) the fear of masking the symptoms and signs of progressive injury or complications of treatment; and (6) the overarching underestimation of pediatric pain because of the young patient's inability to describe or quantify it.

DEVELOPMENTAL DIFFERENCES IN THE PERCEPTION OF PAIN

Although the physiologic response to pain is similar in adults and children, studies involving young children and fetuses suggest that they may actually experience a heightened perception of pain. A child's perception and clinical reaction to pain are influenced by several factors, including age, cognitive level, past experiences, extent of control over the situation, parental responses, parental guidance, and perceived cause and expected duration of the painful experience.

The plan for treatment should account for the differences in the pain response at different stages of development:

- *Younger than 6 months*—Anticipatory fear is not present and the infant reflects the level of anxiety of the parent. Withdrawal, facial grimacing, thrashing, and brief crying are typical expressions of pain.
- *6 to 18 months*—Anticipatory reactions begin to appear in response to fear of a suspected painful experience (e.g., withdrawal of a limb at the sight of a needle).
- *18 to 24 months*—Children begin to use words like "boo boo" and "hurt" in response to expected painful stimuli.
- *3 years*—Children are still unable to understand the reason for pain but are able to localize pain and identify its cause. They are more capable of reliably assessing the pain they feel. Their tolerance for a painful procedure is improved by allowing them some sense of control over certain aspects of the situation (e.g., when it will be performed or how they are positioned).
- *5 to 7 years*—Continued improvement in understanding of purpose and necessity of painful stimuli occur at this age with consequent improved cooperation.
- *8 to 12 years*—Comprehension of the whole process continues to grow with improved understanding/localization of internal pain.
- *Adolescence*—Children are adept at qualifying and quantifying pain, and they develop coping strategies similar to those of adults that help to diminish the perception of pain.

This chapter addresses the current breadth of effective pharmacologic and nonpharmacologic methods to alleviate both pain and anxiety in the pediatric patient before surgical operations and other procedures.

NONPHARMACOLOGIC TECHNIQUES

Needlesticks represent the most common source for iatrogenic procedural pain worldwide. From simple immunizations to venipuncture for laboratory studies to anesthetic injection before dermatologic procedures, laceration repair, and orthopedic reductions, needle pain is ubiquitous. In addition, more and more children are undergoing nonmedical procedures such as body piercings and tattooing (or removal of tattoos).

Untreated pain in the pediatric population has been studied extensively and does have long-term emotional and medical outcomes; these may be lifelong. Children now receive more than 20 needlesticks for immunizations before the age of 2 years and many develop needle phobia because only 1 in 9 is done with any kind of pain control. Adolescents may subsequently avoid needed medical treatment, 16% to 75% of adults surveyed refuse to donate blood, patients with human immunodeficiency virus infection may delay needed blood tests and continue to infect sexual partners, and geriatric patients may refuse influenza and pneumococcal vaccines, all owing to lifelong fear of needle pain.

Clinicians who perform neonatal elective circumcisions know first-hand the benefits associated with the oral administration of "sugar water." The analgesic effect and safety of sucrose for procedural pain both with and without the use of a pacifier (nonnutritive sucking) in neonates have been clearly demonstrated. Effectiveness in older patients is less clear, but it is easy to administer and there are no known adverse effects. Aspiration has not been a reported complication. The influence of age, intercurrent illness, type of procedure, and location of procedure is unclear at this time.

The simplest and most common nonpharmacologic method used with children is *voluntary and external distraction*. Giving the child and parent *verbal reassurance* by providing them with information about the procedure before it is started may help to allay anxiety but might also make it worse. *Hypnosis* has been used to help direct children's focus away from the procedure. Young patients can be taught to *repeat positive statements* to themselves for distraction and to relieve anxiety. These behavioral and cognitive approaches represent useful adjuncts that are frequently overlooked because of perceived time constraints in a busy office or emergency department. *Distraction techniques* include counting or saying the "ABCs," listening to music or watching videotapes, blowing bubbles, spinning pinwheels, using party blowers, playing "I Spy" games, and using "medical play" as employed by child-life programs. *Behavioral treatments* include the techniques of desensitization (the gradual, increasing exposure to a procedure over time), positive reinforcement (rewards and positive statements during or after a procedure), and relaxation techniques (the use of breathing, imagery, and self-hypnosis to decrease anxiety). Although all these techniques have been shown to be very effective, they need props, take time, and may require trained personnel.

The dorsal column of the spinal cord forms a common final pathway for several kinds of afferent neurologic stimuli, including pain, position, temperature sensation, and vibration. By applying the gate theory and stimulating nerve fibers with either cold or vibration, the sensation of sharp pain can be decreased or eliminated by interfering with its transmission because of the other impulses. The use of cold water or ice and the application of vibrating massagers represent effective ways of ameliorating pain. Cold sprays (e.g., Pain Ease [ethyl chloride], Gebauer; Frigi-Dent, Ellman International) have been widely used, but the research into their efficacy in children has been equivocal at best. A device that uses vibration (Buzzy; MMJ Labs) has been proven to work as well as topical anesthetics. Pediatric dentists frequently use tactile vibration with their opposite hand in the delivery of oral anesthesia.

Topical Analgesics and Anesthetics for Children

Also see Chapter 4.

Ease of administration with minimal trauma for the child and parent would make these the medications of choice for a large variety of procedures. However, the reality has never lived up to the promise.

The topical agent most commonly used for laceration repair in children is LET (a combination of lidocaine, epinephrine, and tetracaine), with an onset of action of 20 minutes. EMLA cream is a eutectic mixture of lidocaine and prilocaine but often requires application approximately 1 hour before the procedure, limiting its usefulness. LMX 4 is a nonprescription 4% liposomal lidocaine preparation that is also effective as a topical anesthetic agent.

Zingo (Powder Pharmaceuticals) has been approved by the U.S. Food and Drug Administration (FDA) for use on intact skin to provide topical local analgesia before venipuncture or peripheral intravenous (IV) cannulation in children ages 3 to 18 years. This needle-free product has a novel delivery system using pressurized gas jets that deliver lidocaine hydrochloride monohydrate directly through the epidermis and into the dermis. Zingo comes as a ready-to-use, sterile, single-use, disposable, needle-free delivery system. The product consists of a drug reservoir cassette filled with 0.5 mg lidocaine powder (particle size of 40 μm), a pressurized helium gas cylinder, and a safety interlock. The safety interlock prevents premature triggering of the device. Once Zingo is pressed against the skin, the interlock is released, allowing the button to be depressed to deliver the anesthetic. Triggering the device results in a sound not unlike the popping of a balloon. Because the price of this single-use product is between $20 and $25, its use can increase the cost of venipuncture considerably. Although use can be repeated, if necessary, at a different site (a frequent requirement when attempting to place an IV catheter in dehydrated children), repeated use at the same site is not recommended and the clinician needs to pay heed to the total dosage of anesthetic administered to avoid toxicity.

Zingo provides local dermal analgesia within 1 to 3 minutes of application, and analgesia diminishes within 10 minutes of treatment. Most adverse reactions are application site–related and include bruising, burning, pain, contusion, and hemorrhage. These occurred in 4% of pediatric patients. The most common systemic adverse reactions are nausea (2%) and vomiting (1%). Erythema, edema, pruritus, and petechiae occurred in approximately half of all patients and are brief and self-limited.

Hand-held jet injectors (Madajet, Mada Medical) are available that use high pressure to deliver lidocaine or other local anesthetics fairly quietly through a very small orifice and across intact skin (see Fig. 111.5). For whatever reason, they have not seen widespread use in primary care offices or emergency departments, perhaps because of the cost of equipment or the effort needed to clean the equipment after use. However, if multiple uses are anticipated, even with multiple patients, because there are no needles, only the tips need to be changed between patients. Cleaning the equipment can therefore be conveniently done at the end of the shift or the day.

Pharmacologic Agents for Sedation and Analgesia

The ideal pediatric agent for procedural sedation would have certain characteristics. First, it would be both 100% safe and completely effective for the full range of desired properties—amnesia, analgesia, anxiolysis, motor control, and sedation. It would have rapid onset, fast recovery, and a predictable duration of action and would be completely reversible. In addition, it would be easy to titrate and painless to inject, provide choices for administration route, and be easy to administer. Finally, such an ideal agent would be entirely free of adverse effects and complications.

Needless to say, this ideal pediatric sedative agent has yet to be discovered. A wide range of approved short-acting agents is currently available for use as sedative-hypnotics or analgesics in infants and children. Each of these agents offers advantages in select situations and for specific patients. Procedures that are not painful but require patients to cease moving can be performed with sedation alone. However, painful procedures require both sedation and analgesia.

In 1998, ACEP developed an evidence-based clinical policy for the use of pharmacologic agents for sedation and analgesia that included children. This policy was most recently updated in 2013 and focuses on use of ketamine, propofol, and etomidate or combinations of ketamine and propofol in children. Prior guidelines focused on these, as well as use of fentanyl/midazolam, methohexital, and pentobarbital in children. The specific uses, recommendations, and cautions for these and other agents are addressed in the following section. Specific indications and contraindications are addressed individually for each medication. The important characteristics of selected agents are summarized in Table 2.1 for easy reference.

Sedative-Hypnotic Agents

These medications provide anxiolysis, control of movement, sedation, and often amnesia for the painful event but do not provide analgesia.

TABLE 2.1 Summary of Important Characteristics of Selected Agents

Characteristic	Chloral Hydrate	Fentanyl	Ketamine
Dose and route	Oral: 20–100 mg/kg up to 1 g/dose infants and 2 g/dose older children	IV: 0.5–1.0 µg/kg/dose Titrate q3min to desired effect Suggested max: 2–3 µg/kg	IV: 0.5–1.0 mg/kg; start with 0.25–0.5 mg/kg and titrate to effect q3–5min (suggested max: 1 mg/kg). Combine with atropine 0.01–0.02 mg/kg IV IM: 1–6 mg/kg; usually 2–4 mg/kg, may repeat q5–10 min (suggested max: 6 mg/kg). Combine with atropine 0.02 mg/kg IM Oral: 5–10 mg/kg (suggested max: 6 mg/kg) Combine with atropine 0.02–0.03 mg/kg Rectal: 50 mg/kg
Onset of action/time to peak effect	Onset 15–30 min Peak effect 30–60 min	Onset 1–2 min Peak effect 2–3 min	IV: onset <1 min, peak several minutes IM: Onset 4–10 min, peak 20 min (dose dependent) Oral: Onset >5 min, peak 20 min Rectal: Onset 10–15 min, peak 30 min
Duration of action	60 min; residual sedation may last much longer in neonates and toddlers	20–30 min	IV: 15–45 min IM: 30–60 min Oral: 30–60 min Rectal: 45–75 min
Adverse reactions	Respiratory depression Airway obstruction Paradoxic hyperactivity Delirium Nausea Vomiting Residual sedation (up to 24 hr)	Respiratory depression Bradycardia Dysphoria Delirium Nausea Vomiting Pruritus Urinary retention Smooth muscle spasm Hypotension Allergic reaction Chest wall/glottic rigidity	Laryngospasm Rare respiratory depression Decreased response to hypercarbia Stimulation of salivary and tracheobronchial secretions Mild to moderate increase in blood pressure, heart rate, and cardiac output Emergence phenomena (hallucinations, nightmares, severe agitation) Paradoxic hypotension Skeletal muscle hypertonicity Rigidity Mild disequilibrium Random movements of head or extremities Elevated intracranial and intraocular pressure Nystagmus Vomiting Transient erythematous rash Loss of protective reflexes/aspiration Allergic reaction
Drug Interactions	Coadministration of other sedatives or narcotics increases risk of respiratory complications; can alter warfarin metabolism	Coadministration of other respiratory depressants such as benzodiazepines increases the risk of respiratory depression	Half-life may be prolonged if given with other agents metabolized in the liver Coadministration with benzodiazepines or opiates may decrease the occurrence of hallucinations but may also prolong recovery
Contraindications	Repeated dosing in neonates Patients with significant liver or renal disease Patients with cardiac arrhythmias Patients with porphyria Hypersensitivity	Known allergy or prior serious adverse event	Presence of URI increases risk of laryngospasm to 9% Airway instability (e.g., tracheal stenosis) Presence of potential head injury Known increased intracranial pressure Open globe injury Hypertensive disease Coronary artery disease Psychosis Prior adverse reaction to ketamine Relative contraindications: oral procedures, thyroid disease
Comments	Dose should be decreased in high-risk or debilitated patients Most effective in children <4 years	Slow infusions and lower doses decrease the risk of chest wall rigidity Chest wall and glottic rigidity can be reversed with succinylcholine or naloxone Dose should be decreased in high-risk or debilitated patients Respiratory depressant effects may last longer than opioid effects Use with caution in patients at risk for cholelithiasis Delayed clearance in patients with hepatic disease	Causes dissociative reaction (trancelike state) Provides amnesia, analgesia, immobilization, and sedation All-or-none sedation: no sedation continuum Especially useful for young children (lower incidence of emergence phenomena)
Antagonist	None	Naloxone 10–100 µg/kg IV/IM/SQ Adolescent dose: 0.1–0.8 mg Titrate slowly to patient response waiting 2–3 min between doses	None

BP, Blood pressure; *CHF*, congestive heart failure; *CI*, contraindicated; *CNS*, central nervous system; *CO*, cardiac output; *HR*, heart rate; *IM*, intramuscular; *IV*, intravenous; *SQ*, subcutaneous; *SVR*, systemic vascular resistance; *URI*, upper respiratory infection.

Lytic Cocktail

This time-honored mixture is addressed briefly here for historical reasons and because many older primary care clinicians have used this regimen extensively in the past with great success. The "lytic cocktail" consists of chlorpromazine (Thorazine), promethazine (Phenergan), and meperidine (Demerol) and is given intramuscularly according to the weight of the child: chlorpromazine, 0.5 mg/kg; promethazine, 0.5 mg/kg; and meperidine, 0.7 to 1.0 mg/kg. It is not recommended because (1) the clinician must deal with the side effects of three medications instead of one (polypharmacy); and (2) its effect can be erratic and unpredictable. Up to one-third of children never obtain moderate to adequate sedation; in the other two-thirds, too deep a level of sedation is reached, and it is difficult to reverse. The mean time to discharge after use is 5 hours; the mean time for the child to return to normal behavior ranges from 4 to 34 hours.

Benzodiazepines (Midazolam)

Benzodiazepines provide sedation, anxiolysis, and amnesia but do not provide analgesia. There are several reasons why midazolam (Versed) is the most commonly used agent in this category and the clear drug of choice for pediatric procedures requiring merely sedation and anxiolysis. Midazolam has a rapid onset of action, short duration of action, and rapid recovery time. Although patients may not appear sedated when it is used as a single agent, they become more relaxed and cooperative, and there is the frequent (but not universal) benefit of a marked amnestic response for the event. Controversy exists as to whether this marked amnestic response actually blocks "intrinsic memory" (i.e., although patients may not consciously recall the painful incident, the traumatic event is still recorded in the brain at the subconscious level). For this reason, it is advisable to coadminister an appropriate analgesic agent for painful procedures.

Midazolam offers great flexibility in route of delivery because it can be administered by the *oral, intranasal, sublingual, rectal, intramuscular (IM), or IV route*. Its efficacy is well established. However, when used as a single agent (i.e., not combined with an opiate, ketamine, or droperidol), it is inferior to other regimens or single agents, and patients may appear to be wide awake.

Recommended dosages vary depending on route of administration. *Oral* midazolam is given at doses of 0.5 to 0.7 mg/kg and results in the onset of mellowness at 10 to 30 minutes. Duration of action is 60 to 90 minutes. *Intranasal* midazolam at recommended dosages of 0.2 to 0.5 mg/kg has a more rapid onset of action at 5 to 15 minutes, duration of action of 45 to 60 minutes, and some effects lingering for up to several hours. The solution is drawn up into a tuberculin syringe, the needle is removed, and the drug is instilled into the child's nares with the child supine or the headed tilted back. Recommended rectal doses of midazolam are 0.25 to 0.5 mg/kg, with efficacy reported variably from 62% to 93% for laceration repair. Agitation (reported in up to 17%) has been the major drawback of this route of administration. The recommended IV dose of midazolam is 0.05 to 0.15 mg/kg, and the IM dose is 0.05 to 0.20 mg/kg; time to peak effect is 2 to 3 minutes for the IV route and 10 to 20 minutes for the IM route. Duration of action is 30 minutes to 2 hours.

Adverse effects are uncommon and include the atypical effects of paradoxic agitation and euphoria after administration or an emergence reaction when given IV (1.4%) or orally (6%). Hypotension and respiratory depression are rare but can occur, especially if a narcotic agent is coadministered. The antagonist flumazenil (Romazicon) at a dose of 0.002 to 0.02 mg/kg IV can be given to reverse the effects of midazolam, but patients will require a longer period of observation in recovery (2 hours is commonly recommended) because this agent may have a shorter duration of action than the benzodiazepine, with consequent recurrence of sedation or respiratory depression after the antagonist has worn off.

Chloral Hydrate

In the recent past, chloral hydrate was considered the mainstay of safe, effective pediatric sedation. Although it has a wide margin of safety, chloral hydrate is primarily used to sedate children younger than 3 years of age for diagnostic imaging because its effects on older children are unreliable. It can be administered orally at a dose of 20 to 100 mg/kg up to 1 g/dose for infants and 2 g/dose for older children. Rectal dosing is no longer recommended due to erratic absorption. Unfortunately, chloral hydrate has an unpleasant smell and taste, making it difficult to entice a child to take much of it orally. Peak action occurs at 30 to 60 minutes, making it much less useful than other agents in the emergency setting. Its duration of action is quite variable, with sedation lasting from 1 to 2 hours after administration.

Adverse effects include prolonged sedation (effects can last up to 24 hours), paradoxic agitation, delirium, and coma, but airway obstruction and respiratory depression can occur and there is no consistent dose below which complications do not occur; deaths have been reported. In one published series, adverse events were reported in 33% of children who received chloral hydrate either alone or in combination with other sedatives. This relatively high rate of complications contrasts markedly with the widespread perception of its safety. There is no reversal agent for chloral hydrate, and its use is contraindicated in patients with cardiac, hepatic, and renal disease as well as those with porphyria. In addition, its sedative effects can be difficult to predict. In the past, this agent was frequently used in unmonitored settings. In light of the difficulty in predicting its sedative effects and the attendant risks with its use, it is imperative that procedural sedation protocols for monitoring patients during and after administration of this agent be strictly followed.

Barbiturates (Thiopental, Methohexital, and Pentobarbital)

Barbiturates are primarily used for sedating children younger than 3 years of age to perform diagnostic imaging. They are relatively safe but are contraindicated in patients with porphyria. Major side effects include respiratory depression with apnea and hypotension, both of which are more common when barbiturates are used in combination with opiates or benzodiazepines.

Thiopental (Pentothal) is a short-acting barbiturate with an onset of action of 30 to 60 seconds when given intravenously and only 5 to 8 minutes when given rectally. It has a duration of effect of 15 minutes when given intravenously but up to 1 hour when given rectally. Given intravenously at doses of 20 to 25 mg/kg, thiopental is generally given rectally to children at a dosage of 5 to 10 mg/kg. Thiopental has the notable side effect of decreasing intracranial pressure; it is therefore particularly useful in patients for whom increased intracranial pressure is a concern.

Methohexital (Brevital) is an ultra-short-acting agent with an onset of action of 30 to 60 seconds and duration of effect of 5 to 10 minutes. It is twice as potent as thiopental and can be administered intravenously at a dose of 0.5 to 1.0 mg/kg to children older than 12 years. It should not be administered in younger children and is contraindicated in children with temporal lobe epilepsy because it can cause seizures in this subgroup. Methohexital is rarely used in the emergency department anymore because of a single study (Zink, 1991) of 102 patients, in which 22 patients developed respiratory depression requiring bag-valve-mask assistance. Five of these 22 patients developed transient apnea. If combined with an analgesic medication, respiratory depression is minimized by first administering the analgesic to control pain and then titrating methohexital to needed effect.

Pentobarbital (Nembutal) is a useful barbiturate sedative for longer radiologic procedures such as magnetic resonance imaging and positron emission tomography scans. It has an onset of action of 3 to 5 minutes when given IV and a duration of effect of 30 to 45 minutes. For children and infants older than 6 months, it can be given intravenously at a dosage of 1 to 3 mg/kg and titrated every 3 to 5 minutes to a maximum dosage of 100 mg or intramuscularly at a dosage of 2 to 6 mg/kg to a maximum dosage of 100 mg.

Etomidate

Etomidate is an ultra-short-acting imidazole (nonbarbiturate) hypnotic agent with no analgesic properties. Although studies have been published supporting its safety and efficacy in children, the FDA does not currently recommend its use in children younger than 10 years.

Its consideration as a potential sedative for children stems from its use in the emergency department for both adults and children as an induction agent in rapid-sequence intubation. After the administration of the recommended dose of 0.3 mg/kg IV, etomidate has a rapid onset of action of 5 to 30 seconds and a duration effect of only 5 to 15 minutes. It has the major advantage of decreasing intracranial pressure, like thiopental, and not adversely affecting hemodynamic stability. Reported adverse effects include myoclonus (22% of children receiving it in one study) and oxygen desaturation. When given with fentanyl for analgesia, its safety and efficacy compare favorably with midazolam and fentanyl. Compared with pentobarbital for pediatric sedation before diagnostic imaging, etomidate provided a shorter duration of sedation, greater overall efficacy, fewer failures, and fewer adverse effects.

Propofol

Propofol is a nonopioid, nonbarbiturate sedative-hypnotic agent that produces deep sedation almost immediately after IV administration (the one arm–brain circulation time is approximately 40 seconds). It has no analgesic properties but does produce a modest amnestic effect (although weaker than that of midazolam) and is affectionately known as "oil of amnesia," although this term would be more aptly applied to midazolam. Propofol has been used extensively by anesthesiologists and pediatric intensivists as either an induction agent for general anesthesia or as a sedative in the pediatric intensive care unit for patients requiring mechanical ventilation or other uncomfortable procedures. It acts as a direct muscle relaxant and has both antiemetic and euphoric properties. It has no adverse effects on hepatic or renal function. Propofol does not increase either the intraocular pressure or intracranial pressure. When given in conjunction with an opioid analgesic agent, it provides very effective analgesia and sedation for painful procedures. It also has the benefit of an extremely short recovery time of 5 to 15 minutes. Even if deep sedation inadvertently drifts into general anesthesia, with the attendant need for assisted ventilation, the patient is likely to awaken within a few minutes after cessation of the IV infusion. Nevertheless, controversy remains intense regarding the use of propofol outside of the operating room or intensive care unit or by nonanesthesiologists.

The recommended induction dosage for children 3 to 16 years of age is 2.5 to 3.5 mg/kg, administered IV over 20 to 30 seconds. A lower dosage should be administered in children with an ASA classification of III or IV. IV infusion should follow using a rate of 200 to 300 μg/kg per minute for children 2 months to 16 years of age, decreasing the dose to 125 to 150 μg/kg per minute after the infusion has been running 30 minutes or longer. Higher infusion rates may be required for children younger than 5 years.

Adverse effects noted with propofol include apnea, hypotension, bacterial contamination of the lipid emulsion, and pain at the site of injection (must be administered with lidocaine). Propofol decreases the systemic vascular resistance by an estimated 15% and cardiac output by more than 10%. Hypotension has been reported to occur between 17% and 92% of the time. Respiratory depression results in decreased tidal volume and unpredictable apnea. Oxygen desaturation has been reported in 5% of cases, and simple airway interventions were required in 3% of patients; increased oxygen concentration sufficed for almost all other patients. The need for endotracheal intubation has been reported in only 0.03% of patients. It is difficult to titrate this drug because of both its potency and its rapid onset of action and time to peak effect. Indeed, this may be the root cause for the frequency with which this agent results in a deeper level of sedation than intended.

In several observational studies, propofol sedation has been reported to be both safe and effective when performed by trained emergency department personnel as long as established practice guidelines and hospital protocols are followed strictly. Because it is considered a general anesthetic agent, a second qualified and credentialed provider (i.e., not the clinician performing the procedure) should be present to administer and monitor the patient throughout the procedure until the patient is fully awake. The patient should be carefully monitored with pulse oximetry, as well as capnography and physical monitoring of spontaneous respiratory effort.

Propofol is relatively contraindicated in patients with a known allergy to eggs or soybeans, because current formulations of propofol contain soybean oil, egg lecithin, and egg yolk phospholipids. The generic form contains sulfites, so the brand name Diprivan must be used for sulfite-allergic patients.

Propofol can be coadministered with ketamine, opioid analgesics, or midazolam, but the initiating and maintenance dosage of propofol will likely need to be decreased. The likelihood of sedation events and complications is increased with the coadministration of narcotics. Adverse events are also more likely when propofol is used for sedation in patients with an ASA classification of III or higher.

Other Agents

Ketamine

Ketamine is a phencyclidine derivative and is unique among the sedative-hypnotic and analgesic agents in that it is a "dissociative sedative." It actually produces a trancelike state and provides amnesia, analgesia, immobilization, and sedation. It is therefore an ideal agent for use in young children, often being used as a single agent, resulting in an enhanced safety profile. Unlike other tranquilizers, there is no "sedation continuum" (i.e., the sedative effect is either present or absent). Ketamine is often used in young children for brief, painful procedures such as fracture reduction and laceration repair.

Not only is ketamine very effective when used according to practice guidelines, it is very safe. Patients almost always retain protective airway reflexes, intact upper airway muscular tone, and spontaneous breathing. It can be administered orally (5 to 10 mg/kg), rectally (50 mg/kg), *IM* (1 to 6 mg/kg), or *IV* (0.5 to 1 mg/kg). IV doses can be titrated to effect every 3 to 5 minutes, starting with 0.25 to 0.5 mg/kg. Onset of action is less than 1 minute with IV use, with maximal effect noted at approximately 3 to 4 minutes. Onset of action is 4 to 10 minutes with IM use, with maximal effect noted at 20 minutes. Oral and rectal use results in an even slower onset of action, with peak effect at 20 to 30 minutes. With IV use the duration of effect is short, 15 to 45 minutes, but recovery times are much longer (30 to 75 minutes) and less predictable for oral, IM, and rectal use.

Side effects of ketamine include both vomiting and increased salivation. The latter can be controlled by preadministration of either atropine or glycopyrrolate. Laryngospasm occurs very rarely and can be managed by positive-pressure bag-mask ventilation. Hypertonicity can also occur. Ketamine is most known for the frequent occurrence of unpleasant hallucinations and nightmares, as well as severe agitation during emergence from sedation. These emergence phenomena are much more common in patients older than 15 years and extremely rare in younger children. Coadministration of midazolam has been proposed to minimize this adverse effect, but to date there are no convincing large studies to support this. Although midazolam also decreases the incidence of vomiting with ketamine, it also results in a fourfold to fivefold increase in the incidence of oxygen desaturation. Still, ketamine with midazolam has been associated with fewer adverse events compared with ketamine combined with fentanyl or propofol, especially in children younger than 10 years.

Unfortunately, ketamine has many contraindications, including age younger than 3 months, airway instability, cardiovascular or pulmonary diseases including bronchospasm, glaucoma or eye injury, increased intracranial pressure or head injury, porphyria, thyroid disease, and psychosis.

Nitrous Oxide

Also see Chapter 3.

Inhaled nitrous oxide provides amnesia, mild analgesia, anxiolysis, and sedation when mixed in a 1:1 ratio with oxygen and

administered through a demand-valve mask. This system requires patient cooperation, so this method of sedation is generally reserved for children older than 4 years.

At the concentrations usually used for sedation and analgesia, nitrous oxide use preserves protective airway reflexes, normal blood pressure and pulse, and spontaneous respirations. It has an excellent safety profile, and adverse effects are typically mild, including nausea, vomiting, and occasional dysphoria. It can be used alone or in combination with other sedatives and analgesics, and it has a proven track record of efficacy for a variety of painful procedures. Contraindications include pregnancy, vomiting, and the presence of known or presumed "trapped air" (e.g., bowel obstruction, pneumothorax, perforated viscus, or middle ear infection).

Opioid Analgesics (Fentanyl)

Opioids (narcotic agents) are widely used and well-established analgesics. Although morphine is the prototype drug in this class, and meperidine also has been used extensively in the past, fentanyl has rapidly become the opioid agent of choice for children requiring potent analgesia during procedural sedation. Fentanyl is a synthetic opioid that has 75 to 125 times the potency of morphine and a very rapid IV onset of action (1 to 2 minutes) with a relatively short duration of action (20 to 30 minutes). It is administered in an initial IV dose of 0.5 to 1 μg/kg, and its pharmacokinetics permit smooth and safe titration either alone or in combination with midazolam at intervals of approximately 3 minutes until the desired effect is achieved.

Fentanyl has additional *advantages* over the longer-acting narcotic agents. It lacks the histamine release characteristic of morphine and the buildup of very-long-acting metabolites occasionally seen with meperidine (the so-called *serotonin surge syndrome*). It is also effective when administered intranasally or by nebulizer.

Adverse effects of fentanyl include hypoxemia and respiratory depression. Pruritis, bradycardia, nausea, and vomiting can occur. Chest wall and glottic rigidity are uncommon but serious complications and have been reported in neonates receiving a single dose of fentanyl between 3 and 5 μg/kg. In fact, fentanyl has the highest reported complication rate of any agent used for procedural analgesia and sedation. However, fentanyl is rarely used as a single agent so it is likely that much of the excess risk is due to polypharmacy. The practicing clinician needs always to remain vigilant when using opioid-sedative combinations, especially when three or more medications have been administered.

The antagonist naloxone is an effective reversal agent for fentanyl. It is administered IV at a dose of 0.1 mg/kg for children 0 to 5 years of age and 2 mg/kg for children older than 5 years. The dose can be repeated. Its onset of action is 1 to 2 minutes, with a duration of effect of 20 to 40 minutes, resulting in complete reversal as a single dose most of the time when used with fentanyl. Incidentally, when used to reverse the effects of meperidine, naloxone can result in normeperidine-induced seizures. If glottic or chest wall rigidity occurs, a neuromuscular blocking agent such as succinylcholine, rocuronium, or vecuronium may need to be administered to achieve an oral or endotracheal airway, along with bag-mask positive-pressure ventilation.

If any significant sedation and anesthesia is going to be used other than basic anxiolytics (what was formerly called "conscious sedation"), strict adherence to safety and established guidelines is imperative (also see Chapter 1).

EQUIPMENT

The equipment required for pediatric sedation and analgesia comprises everything that is needed to effectively and safely monitor the patient through induction, maintenance, and recovery from the effects of the medications used. In addition, equipment needs to be readily at hand to manage any complication that may arise from the unintended escalation of sedation level to either deep sedation or general anesthesia. A list of basic essential equipment appears in Box 2.1.

BOX 2.1 Equipment Needs and Considerations for Pediatric Procedural Sedation

- Oxygen with a system that is capable of administering at least 90% O_2 at 10 L/min for 60 minutes, nasal cannulas, oxygen mask
- Bag-mask system for positive-pressure ventilation
- Laryngoscope with appropriately sized blades and endotracheal tubes
- Suction catheters and apparatus
- Emergency cart with appropriate medications and Breslow tape
- Defibrillator
- Pulse oximeter, continuous
- Electrocardiograph monitor, continuous
- Noninvasive blood pressure apparatus
- Emergency antagonists, including naloxone and flumazenil
- Succinylcholine if fentanyl is being used
- IV start kit and appropriately sized IV catheters
- 500-mL bags of normal saline and Ringer lactate
- Telephone or radio for summoning assistance in an emergency
- End-tidal CO_2 monitor (when available)
- Equipment for administering blood and blood components need to be readily available if transfusion becomes necessary
- Intraosseous catheter kit should be immediately available if IV access is lost and a standard IV line cannot be started

The majority of this equipment is available in the Banyan kit (a "crash cart in a suitcase"), available commercially.

BOX 2.2 Components of the Children's Hospital of Wisconsin Sedation Model

Monitoring and personnel requirements
Nothing-by-mouth guidelines
Presedation evaluation
Focused present and past history
Focused physical examination
Vital signs
Graded risk assessment documentation
Assignment of ASA physical status score
Generation of sedation plan
Informed parental consent
Equipment and monitoring standards based on actual level of sedation
Quantitative sedation scoring
Time-based recording of vital signs, oxyhemoglobin saturation, and sedation level
Recovery and discharge criteria
Standardized record

Modified from American Society of Anesthesiologists (ASA) and American Academy of Pediatrics (AAP) guidelines. Each of these components is specifically prompted on a uniform sedation documentation record.

PRESEDATION EVALUATION

Box 2.2 summarizes a comprehensive and accepted set of required components for the safe administration of procedural sedation in the pediatric patient. This sedation model was developed at the Children's Hospital of Wisconsin. Pediatric sedation does not relieve the clinician of the need to explain the anticipated procedure to both the child (when their cognitive level warrants) and the parent or

TABLE 2.2 Airway Assessment

Physical Characteristic	Specific Concerns
Body habitus	Obese vs. thin Size and length of neck
Presence of micrognathia (see Fig. 2.1)	Receding mandible Size of mandible in relation to face
Dentition status	Protruding incisors (buck teeth) Poor dental condition; caries Loose teeth or crowns Distance between upper and lower teeth; associated with the presence of high-arched palate
Joint mobility	Mobility of the head at the atlanto-occipital joint (see Fig. 2.2) Mobility of the mandible at the temporo-mandibular joint Mallampati classification (see Chapter 1, Fig. 1.2)
Thyromental distance (>6 cm, 3 fingerbreadths)	By measuring the thyromental distance, the anatomic proximity of the glottis to the mandible and base of the tongue can be gauged
Intraoral concerns	Status of tonsils, intraoral tissues, torus palatinus, tumors, trauma Redundant tissue Presence of neonatal teeth Intraoral, lingual, or labial body ornaments
Nasal concerns	Body ornaments: studs and rings Patient may require a nasal airway rather than oral

guardian. Informed consent for both the sedation and the procedure should be obtained and documented in the medical record. An example of a procedural sedation informed consent form is available at www.expertconsult.com.

A focused history and physical assessment should be performed before administering any sedative or analgesic agent. This evaluation can be performed any time within 30 days of an intended procedure, depending on institutional requirements and standards. However, the patient must be reassessed immediately before initiating procedural sedation to ensure his or her suitability for sedation, as well as to reconfirm the appropriateness of the planned sedation regimen. The sedation plan and choice of sedative/analgesic agent(s) should be clearly documented on the presedation evaluation form.

The history should include allergies, use of medications or illicit drugs, diseases, operations, hospitalizations, previous exposure to sedation or general anesthesia, untoward reactions to anesthetic agents in the past, relevant family history, and the time and content of the last oral intake. The physical examination should include auscultation of the heart and lungs, as well as a careful assessment of the airway (Table 2.2 and Figs. 2.1 and 2.2). Special attention should be given to identifying anatomic or clinical conditions that might interfere with endotracheal intubation and resuscitation should they become necessary. These conditions are summarized in Box 2.3.

Pediatric patients need to be assigned an ASA Physical Status Classification before performing any emergency or elective procedure. This classification is summarized in Table 1.2.

A pediatric patient's suitability for mild, moderate, or deep sedation outside of the operating room can range from excellent to very poor in each of the ASA classes but is generally expected to be good for classes I and II. Formal published recommendations suggest that an anesthesiologist or subspecialist should be consulted for patients with ASA classes of III and IV to assist with airway abnormalities and management, as well as other special needs. At the least, in clinical settings where such assistance is unavailable, a second trained and experienced clinician should be consulted whose entire focus is the management of sedation throughout the procedure. For elective procedures, transfer to a larger facility where such help is available should be seriously considered.

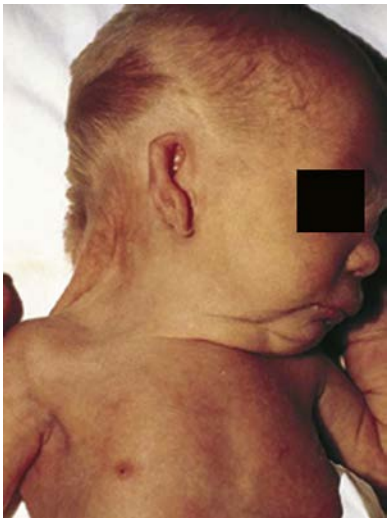

Fig. 2.1 Micrognathia.

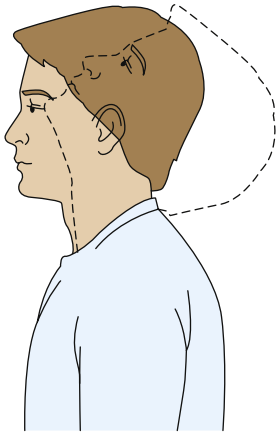

Fig. 2.2 Mobility of the head at the atlanto-occipital joint.

BOX 2.3 Sedation Graded Risk Assessment Tool: Sedation Risk Factors

Snoring, stridor, or sleep apnea
Craniofacial malformation
History of airway difficulty
Vomiting, bowel obstruction
Gastroesophageal reflux
Pneumonia or oxygen requirement
Reactive airways disease
Hypovolemia, cardiac disease
Sepsis
Altered mental status
History of sedation failure
Inadequate nothing-by-mouth time
No identified risk factors

Medical conditions and patient characteristics with known potential for increasing the risk of procedural sedation are specifically prompted on the sedation record.

Fasting Before Sedation

There is limited evidence to support an optimum duration of fasting before sedation to reduce the risk of aspiration. ASA guidelines, which are based on expert opinion and consensus, recommend a minimum fasting period of 2 hours for clear fluids, 4 hours for breast milk, and 6 hours for formula, nonhuman milk, and solids. For children with normal airways and no clinical predisposition to aspiration, a systematic review of randomized trials failed to find any benefit for fasting from fluids for more than 6 hours compared with 2 hours. In addition, no statistically significant differences in intraoperative gastric volumes and pH were noted. It should also be noted that all this research is related to general anesthesia in the operating room; any extrapolation of data to other clinical settings may not apply. According to an expert panel that published their findings in *Annals of Emergency Medicine* in 2007, the following considerations related to the risk of aspiration should dictate the planned depth and length of procedural sedation in the emergency department:

- Possibility of a difficult airway
- Conditions predisposing to esophageal reflux, including elevated intracranial pressure, gastritis, bowel obstruction, or ileus
- Age less than 6 months
- Severe systemic disease with functional limitation (ASA class ≥3)
- Timing and nature of last oral intake
- Urgency of procedure

If the fasting guidelines cannot be followed, the following should be taken into consideration:

- Delay of the procedure.
- Referral to a licensed anesthesia provider to help protect the airway.
- In emergent and urgent situations, the increased risk of aspiration must be weighed against the benefits of the procedure. The lightest effective sedation should be used.

Personnel

Clinicians who administer procedural sedation must fully understand the pharmacology of the medications they use. They must also have the breadth of clinical experience and judgment to select a regimen that is appropriate for both the patient and the intended procedure. Because altered consciousness represents a continuum and not discrete "quantum" levels, clinicians should have the requisite training and current skill to deal effectively with complications arising from the patient drifting to the next deeper level of sedation than that intended.

Two trained and credentialed individuals are required when a patient is significantly sedated for a procedure, one to perform the procedure and the second to administer and monitor the sedation. Ideally, both individuals would be clinicians competent at inducing anesthesia; this choice is probably prudent if deep sedation is planned (at the least, the second individual should be a licensed nurse anesthetist). In practice, the second individual is either a nurse or trained assistant (certified medical assistant, certified nursing assistant, or respiratory therapist). He or she monitors the patient and documents vital signs, level of consciousness, timing and dose of medication administration, and any complications. If the assistant is not a clinician trained in sedation management, the clinician in charge of the procedure must be able to stop the procedure at any time to manage complications arising from sedation and analgesia.

Monitoring

Documentation of any procedure should be scrupulous and complete and include a description of the level of responsiveness of the patient, otherwise known as the sedation score (see Chapter 1, Table 1.1). Document the issues discussed when obtaining informed consent in the patient record. Some medicolegal experts also recommend asking a parent or guardian to sign a form listing each procedure that the clinician might perform. With regard to pediatric sedation, the clinician should document how well the patient tolerated the method used. If side effects are noted or complications encountered, full documentation—including a careful record of all measures and medications used in dealing with them—must be given in the sedation report in the patient's medical record. A time-based record of heart rate (electrocardiographic monitor or pulse oximeter), oxygen saturation (pulse oximeter), and end-tidal CO_2 (if used), as well as nursing assessments and monitoring, must be made until the patient is fully recovered. For patients with an underlying illness or for whom deep sedation is planned, these measurements along with vital signs should be taken and recorded at least every 5 minutes.

The nurse should record all medications given (dose, route of administration, and time given), as well as fluids, blood loss, and any unusual events or complications. Supplemental oxygen should be administered prophylactically in all cases. IV access is strongly encouraged during pediatric sedation and analgesia, although it is not absolutely necessary for lighter levels of sedation or when sedative agents are administered by oral, nasal, rectal, or IM routes. However, in these cases, equipment and skilled personnel capable of immediately establishing vascular access need to be present.

Recovery and Discharge Criteria

Monitoring must be continued by trained personnel until the infant or child has met preestablished criteria for safe discharge. These criteria include the following:

- Airway patency and stable cardiovascular function
- Easy arousability with intact protective reflexes
- Ability to talk (if age appropriate)
- Ability to sit up without assistance (if age appropriate)
- Adequate level of hydration

Disabled patients, young children, and infants should be observed until they return to the same level of responsiveness as that noted before sedation. Numerous scoring systems have been published. Table 2.3 outlines the Aldrete Recovery Scale, a common system used at many health care institutions throughout the United States. As most of my residents and nurses have heard me chant, "When they meet the Aldrete, the patient's all ready."

TABLE 2.3 Aldrete Recovery Score

Measure	Description	Points
Activity	Voluntary movement of all limbs to command	2
	Voluntary movement of two extremities to command	1
	Unable to move	0
	Apneic	0
Respiration	Breathe deeply and cough	2
	Dyspnea, hypoventilation	1
Circulation	BP ±20 mm Hg of preanesthesia level	2
	BP ±20–50 mm Hg of preanesthesia level	1
	BP >50 mm Hg of preanesthesia level	0
Consciousness	Fully awake	2
	Arousable	1
	Unresponsive	0
Color	Pink	2
	Pale, blotchy	1
	Cyanotic	0

Total score must be >8 at the conclusion of the monitoring.
BP, Blood pressure.

Postsedation Concerns

Available evidence suggests that infants and children who have not experienced an adverse event during sedation can be safely discharged after 30 minutes of observation and monitoring.

What about the risk of adverse events occurring after discharge? In a large, well-designed, prospective study of 1341 pediatric sedation events occurring in the emergency department setting, adverse reactions were noted in 14% of patients and potentially life-threatening events occurred in 12%. Only 8% of all adverse events occurred after the procedure. Every child who experienced a postprocedure event had a similar adverse effect earlier in the sedation. All serious, potentially life-threatening events occurred within 25 minutes of the last sedative/analgesic dose. Parents or guardians should nevertheless be advised that minor side effects may occur after discharge from the recovery area and that full recovery after moderate or deep sedation may be prolonged. Discharge instructions should include the telephone number of a trained staff member to field any parental questions or concerns.

Patient Education Guides

See the sample patient and parent education handout available at www.expertconsult.com.

CPT/Billing Codes

99151	Moderate sedation services provided by the same physician performing the diagnostic or therapeutic service that the sedation supports, requiring the presence of an independent trained observer to assist in the monitoring of the patient's level of consciousness and physiologic status in patients younger than 5 years of age, first 15 minutes intraservice time
99152	Patients age 5 years or older, first 15 minutes intraservice time
99153	Each additional 15 minutes intraservice time (List separately in addition to code for primary service)

NOTE: This code list does not include simple or minimal office sedation techniques (anxiolysis).

Suppliers

(See contact information available at www.expertconsult.com.)

Banyan Corporation

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CHAPTER 3

NITROUS OXIDE SEDATION

Marjon B. Jahromi

Nitrous oxide (N_2O) sedation was first used as an anesthetic agent in 1844 and can be considered a safe alternative to intravenous (IV) sedation. N_2O sedation has a long history of safety in the medical and dental community. It is now used by approximately 95% of pediatric dentists and is growing in popularity in general dental and medical offices. Most U.S.-trained dentists become proficient in N_2O sedation as part of their undergraduate dental training. It is not necessary to have extensive experience with IV sedation to be able to perform N_2O sedation safely. Gaining experience with N_2O sedation can be achieved by observing an experienced practitioner and performing the sedation under supervision. Alternatively, continuing education courses are available. Practitioners who are not familiar with the technique are encouraged to participate.

N_2O is a relatively insoluble drug and is a rapidly effective sedative with an onset of effects within 2 to 3 minutes of administration and peak effects within 5 minutes. Dosing can be adjusted easily and rapidly to increase or decrease depth of sedation during the procedure. Recovery time is short because elimination through the lungs occurs as rapidly as absorption. N_2O is not metabolized in the body to any significant extent and therefore can be used safely on most patients. Patients remain conscious and protective reflexes are intact, so there is minimal risk of aspiration or oversedation. In addition, N_2O does not cause respiratory depression, making it safer than fentanyl, midazolam, or chloral hydrate. Technically, it is easier to perform than IV sedation because there is no need to gain venous access. N_2O is administered through a face mask or nasal hood that is simply placed on the patient's face.

INDICATIONS

- Anxious and apprehensive patients undergoing minor office surgical or dental procedures
- Patients needing increased pain reaction threshold
- Patients who are unable to tolerate other sedatives

CONTRAINDICATIONS

- Pregnancy (first trimester)
- Airway obstruction and severe asthmatic conditions
- Severe psychiatric disorders (N_2O can cause dreaming and hallucinations)
- Pulmonary hypertension
- Air embolism
- Pneumothorax
- Severe cardiac disease
- Hyperthyroidism
- Sickle cell anemia
- Chronic bronchitis/emphysema or pulmonary bleb
- Bowel obstruction
- History of stroke (relative)
- Hypotension (relative)

N_2O should *not* be used to replace local anesthesia but rather as an adjunct to local anesthesia. N_2O sedation is not a good option to control defiant or erratic behavior.

ADVANTAGES

- Rapid onset; monitoring time during recovery is brief
- Good analgesic and amnestic (limited) properties
- Unlike IV sedation, when N_2O is used alone, a driver is not needed once the patient has recovered. Patients should be monitored for approximately 30 minutes after the use of N_2O to ensure return to baseline functional status before discharge.
- Patients may resume all normal activities after discharge and are not limited in their activities.

LIMITATIONS

- Lack of potency
- Expense of equipment
- Training required to become proficient

EQUIPMENT

- Inhalation sedation machine (Fig. 3.1)
- Breathing circuit
- Reservoir bag
- Scavenging system
- Nasal hood or facial mask
- Oxygen and N_2O supply (N_2O is stored in compressed form as a liquid in cylinders)
- Pulse oximeter
- Oral pharyngeal airway available
- Emergency cart with appropriate drugs (consider the Banyan kit; see Chapter 212)

PRESEDATION ASSESSMENT AND CONCERNS

Fig. 3.2 shows an anesthesia evaluation form that can be used before and after the procedure.

- A complete medical history should be obtained from the patient. Relevant information includes a history of cardiac or respiratory disease, medications, allergies, prior surgeries and complications from anesthesia, history of tobacco use, and history of substance abuse.
- The oropharynx should be thoroughly evaluated for any abnormalities or evidence of obstruction. A history of sleep apnea may indicate airway abnormalities such as narrow airways and tonsillar hypertrophy. Obesity, especially involving the face and neck, may lead to difficulties in spontaneous ventilation under sedation.
- N_2O will potentiate drugs that depress the respiratory system.
- The procedure and all possible sensations should be described to the patient in advance. N_2O can produce a feeling of eupho-

Fig. 3.1 **Accutron 4-Cylinder Portable Manifold.** (Courtesy Accutron, Inc., Phoenix, AZ.)

ria, dreaminess, and detachment. It can also cause numbness and tingling of the extremities. It may cause nausea, confusion, and sexual hallucinations in higher doses.

Preprocedure Patient Preparation

- An experienced assistant trained in Basic Life Support should always be present.
- Patients do not need to be fasting if N_2O is the sole anesthetic agent. However, if an oral sedative is to be used in combination with N_2O, confirm that the patient has fasted for at least 6 hours for solid foods and nonclear liquids and at least 6 hours for clear liquids.
- Perform a full check of the inhalation sedation machine to ensure that it is safe to use and that it has an adequate supply of gases for completion of the procedure. N_2O is a compressed liquid at room temperature with a pressure of 745 pounds per square inch. A full E cylinder of N_2O will have 1590 mL of gas. The pressure indicator in a N_2O tank will show a constant pressure until only about 20% (400 mL) of N_2O is left in the cylinder. This is very different from oxygen, which is a nonliquified gas. The pressure indicator in an oxygen tank will indicate a proportional decrease in pressure as the volume of the gas is depleted. Therefore the pressure indicator of a N_2O tank cannot be used to estimate the amount of gas remaining in the cylinder.
- The scavenging system should also be checked for proper functioning. It is below the standard of care to operate a N_2O unit without a scavenging apparatus.
- The health care practitioner should have all the necessary equipment and be prepared to handle all medical emergencies in the event the patient should reach a deeper level of sedation than initially planned. Although not required, a pretracheal stethoscope is an excellent method to monitor the patient's respirations and heart sounds. This may prevent the patient from becoming oversedated and losing consciousness. The conventional or newer wireless pretracheal stethoscope can be easily obtained by any health care practitioner (Figs. 3.3 and 3.4).

Documentation

- Informed consent should be obtained for both the planned procedure and the N_2O sedation. All written and verbal instructions, including consent with risks, benefits, alternatives, and contraindications, should be documented.
- The patient's vital signs, including blood pressure, heart rate, and oxygen saturation by pulse oximetry, should be recorded at regular intervals throughout the procedure and during recovery.
- Any standardized anesthesia form can be used for documentation (Fig. 3.5). Alternatively, vitals, level of sedation, and concentration of N_2O being administered can simply be recorded at 5-minute intervals (also see Chapter 1).

Technique

1. Always have a Basic Life Support–trained assistant present.
2. Begin the inhalation sedation session with a full check of the inhalation sedation machine to ensure that it is safe to use and that it has an adequate supply of gases to allow the procedure to be completed. Also check the scavenging system for proper functioning.
3. Once the presedation check has been completed, position the patient properly for the procedure to be performed. Obtain and record baseline vital signs, including continuous pulse oximetry. A pretracheal stethoscope may also be placed at the lower end of the trachea and midline to the neck for additional monitoring of respirations.
4. Place a nasal hood or facial mask on the patient's face. The nasal hood should fit snugly around the patient's nose to minimize any leakage of gas. Nasal hoods come in a variety of sizes and may be scented for optimal patient comfort. Most nasal hoods manufactured now are also latex free. It may help to ask the patient to help achieve a snug fit. Also telling them they can adjust the hood or mask as needed gives them a sense of control.
5. Introduce 100% oxygen only. The initial gas flow rate should be set to 6 or 7 L/min for an average-sized adult (4 or 5 L/min for most children). The patient should be instructed to take deep breaths through his or her nose. Adjust the flow rate so that the reservoir bag can be seen moving during each breath. It should not be bulging but rather about two-thirds full before inspiration, and should not empty completely with inspiration. If the reservoir bag empties completely, the flow rate should be increased until about two-thirds of the bag empties with each patient breath. It is best to err with more flow than needed initially to avoid a suffocating feeling. As the patient becomes relaxed, it may be possible to reduce the flow of oxygen.
6. Once the flow rate has been adjusted to the proper level, introduce the N_2O. Patient tolerance and N_2O requirement vary significantly for each person. It is important to titrate the dose slowly to prevent oversedation. Oversedation should be avoided because it can result in unpleasant feelings for the patient. Initially, 10% N_2O is introduced and the patient is allowed to breathe this mixture for 1 minute. The O_2 level should also be adjusted to maintain the constant flow rate that was previously established. Some inhalation sedation machines will also automatically decrease the O_2 flow as the N_2O flow is increased.
7. If this dose provides adequate sedation, the operative or dental procedure can begin. Signs of adequate sedation include a reduction in anxiety, increased relaxation, slowing of the blink reflex, decreased response to painful stimuli, and general decrease in movements.
8. If this level of sedation is not sufficient, provide an additional 10% N_2O and allow the patient to breathe the mixture for 1 minute before reassessment. This cycle can be repeated to a maximum mixture of 70% N_2O to 30% O_2. Document the level and length of N_2O administered in the patient's medical chart.
NOTE: Minimum dose is 10% N_2O:90% O_2. Maximum concentration is 70% N_2O to 30% O_2. Average maintenance dose is typically between 20% N_2O to 80% O_2 and 40% N_2O to 60% O_2. Almost all ambulatory N_2O/O_2 delivery systems have an oxygen fail-safe mechanism that prevents N_2O from being administered unless there is adequate O_2 flowing to the system. Therefore it is not possible to administer 100% N_2O.

Patient: _____
Operating Surgeon: _____ Procedure: _____
Age: _____ Height: _____ Weight: _____ Pre-Op B/P: _____

MEDICAL HISTORY:
_____
_____
_____

ANESTHETIC HISTORY:
Personal: _____
Family: _____

REVIEW OF SYSTEMS:

Heart:	CP DOE Orthopnea HTN CHF Dysrhythmias	_____
Pulmonary:	COPD Asthma URI Bronchitis Pneumonia	_____
Endocrine:	DM Thyroid Obesity Steroid use	_____
GI:	PUD Reflux HH	_____
Liver:	Hepatitis Cirrhosis	_____
Mus. Skel.:	Fractures MH	_____
CNS:	Seizures CVA Paralysis HA TIA	_____
GU:	CRF Infections Pregnant	_____
Hemo:	Coagulopathy Sickle Cell	_____
Habits:	Smoking EtOH Drugs	_____

MEDICATIONS: _____

ALLERGIES: _____

PHYSICAL EVALUATION:
Heart: _____
Pulmonary: _____
Airway: Classification 1 2 3 4 Head and Neck: _____ FBO: _____ Loose/Missing teeth _____

HOSPITALIZATIONS: _____
_____

ASA CLASSIFICATION: 1 2 3 4 5 E **NPO:** _____

ANESTHESIA PLAN: General Anesthesia Monitored Anesthesia Care Nitrous Oxide

PRE-OPERATIVE MEDICATIONS: _____

CONSENT (Risks/Benefits/Alternatives discussed, Questions answered, Accepts risks) _____

_____ _____
Date / Time Signature

DISCHARGE SUMMARY: ☐ VSS ☐ Alert/Awake ☐ Ambulatory ☐ IV removed intact ☐ Post-op instructions given to

Post-op transport provided by: Room Air SpO_2: %

POST-DISCHARGE NOTE:

ANESTHESIA EVALUATION

Fig. 3.2 Anesthesia evaluation form used both before and after the procedure to document discharge status.

Fig. 3.3 Conventional pretracheal stethoscope. Chest piece from Hull Anesthesia, Inc. Earpiece and cord from Westone.

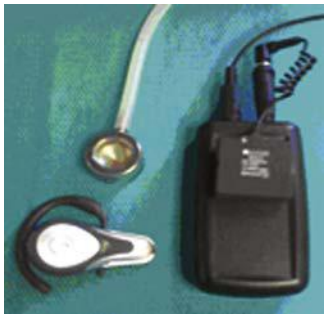

Fig. 3.4 Wireless pretracheal stethoscope. (Courtesy Sedation Resource, Inc., Lone Oak, TX.)

9. Immediately reduce the N_2O concentration with the first sign of oversedation. *Signs of oversedation* include agitation, sweating, nausea, vomiting, lack of cooperation, diaphoresis, inability to keep eyes open, decreased response to questions, and loss of consciousness. The patient is also at risk for silent aspiration if vomit reaches the epiglottis. Patients may also complain of unpleasant feelings such as intense tingling or detachment from reality. It is imperative that the health care provider constantly assess the level of sedation because changes in patient comfort may occur rapidly.
10. With lengthy administration (>30 minutes), reduce the N_2O concentration. The duration of exposure to an anesthetic can have an effect on recovery time. Accumulation of anesthetic in tissues such as muscle, skin, and fat increases with continuous inhalation and can delay recovery time. This is especially true of the more soluble anesthetics, but it can also occur to some degree with low-solubility anesthetics.
11. Once the procedure is complete, the N_2O can be reduced and the patient returned to breathing 100% O_2 for at least 5 minutes. This should be achieved by reducing the inspired concentration of N_2O by 20% per minute until it is reduced to zero. Patients should indicate they are feeling fine and not drowsy, groggy, light-headed, dizzy, or nauseated before removing the 100% O_2.

Complications

- Oversedation or prolonged administration can lead to agitation, sweating, nausea, vomiting, feelings of detachment, confusion, hallucinations, and unconsciousness.
- N_2O can cause myocardial and respiratory depression in high doses (>70%).
- *Chronic* effects of N_2O exposure can include bone marrow suppression, mainly through inhibiting enzymes that depend on vitamin B_{12}. As a result, myelin formation and DNA synthesis may be affected. Megaloblastic anemia, pernicious anemia, peripheral neuropathies, and an increased incidence of miscarriages can also occur as a result of chronic N_2O use. Central nervous system degeneration is common among those who abuse N_2O. Scavenging of waste gases is therefore crucial to protect office staff. The National Institute for Occupational Safety and Health recommends limiting the room concentration of N_2O to 25 ppm.

Postprocedure Management and Concerns

- Monitoring of vital signs along with pulse oximetry should be continued during recovery.
- The patient should breathe 100% O_2 for 3 to 5 minutes after the procedure to prevent diffusion hypoxia.
- Diffusion hypoxia is a condition caused by the rapid release of N_2O from the blood. Because N_2O is insoluble, it leaves the bloodstream rapidly once the inspired concentration is reduced. If the inspired concentration of N_2O is high, then a large amount of gas will quickly emerge from solution into the alveoli, displacing O_2. This mechanism requires large volumes of N_2O to be released from the alveoli, which usually occurs during the first 5 minutes of recovery. Room air does not have an O_2 concentration high enough to compensate for the high N_2O concentration released from the alveoli after the procedure. Thus, hypoxia can occur if supplemental O_2 is not given and if the patient is not allowed to breathe 100% O_2 for 3 to 15 minutes after the discontinuation of N_2O sedation.
- Symptoms of diffusion hypoxia include disorientation, nausea, and severe headache.
- All written and verbal instructions that were given should be documented.
- Postoperative instructions are more relevant to the actual procedure that was performed; therefore there are no specific postoperative instructions for N_2O sedation.
- The patient should be alert and oriented before discharge. If N_2O was the only sedation used, the patient may drive himself or herself home. However, if an oral sedative was used in combination with N_2O, a driver is required to take the patient home.

CPT/Billing Codes

01999	Unlisted anesthesia for planned vaginal delivery
99151, 99152, 99155, or 99156	Sedation with or without analgesia (conscious sedation); intravenous, intramuscular or inhalation

Note: 99153 or 99157 may be reported for additional intraservice time as necessary.

Suppliers

(Full contact information available at www.expertconsult.com.)

N_2O Machines and Supplies
Accutron, Inc.
Henry Schein Dental

Pretracheal Stethoscopes
Hull Anesthesia, Inc.
Sedation Resource, Inc.
Westone

Acknowledgment

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M F	Age	Ht	Wt	BP	SpO_2	ASA 1 2 3 4 5 E	NPO
MEDICAL HISTORY:						**MEDICATIONS:**	
						ALLERGIES:	
						PRE-OP MEDICATIONS:	
						☐ Unable to obtain baseline vital signs, patient is uncooperative	

Time:

SpO_2																			
ECG																			
Temperature																			

☐ GA
☐ MAC
☐ Supine
☐

MONITORS
☐ Precordial
☐ Pulse Oximeter
☐ NIBP
☐ ECG
☐ Respirations
☐ Temperature
☐
☐

IV
☐ Hand
☐ Arm
☐ ACF
☐ Foot
☐ R ☐ L
☐ 20 ☐ 22 ☐ 24

200
150
100
50

Notes Anes X Surg O

Oxygen																			
Total																			

AIRWAY
☐ Nasal Cannula
☐ Nasopharyngeal
☐ Orotracheal Tube
☐ Nasotracheal Tube
☐ L M A
☐ R ☐ L
20 22 24 26

NOTES: ☐ Equipment checked ☐ Patient examined ☐ NPO verified ☐ Consent obtained

ANESTHESIA TIME	Procedure: Date:	Patient Identification:
Anes end:	Location:	
Anes start:	Surgeon:	
Anes total:	Anesthesiologist:	

Fig. 3.5 Anesthesia record.

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CHAPTER 4

TOPICAL ANESTHESIA

Suraj Achar • Jonathan Chan

Topical anesthesia offers patients an alternative to local injections. Such an alternative may be very helpful in the anxious patient, especially those in pain from an injury or anticipating pain from a planned procedure. The ideal topical anesthetic would provide 100% anesthesia with a rapid onset, prolonged duration, and no local or systemic side effects. To date, the perfect topical agent has not been developed; however, new formulations have improved efficacy and application options. (Also see Chapters 5, 6, and 183.)

Compared with local injectable anesthetics, there are many benefits and some drawbacks with topical anesthetics. Application of topical anesthetics is painless and does not distort wound margins in laceration repairs. Less sedation may be needed. Drawbacks include the extra time required for topical anesthetics to take effect and, occasionally, inadequate analgesia requiring infiltrative anesthesia.

Although the first topical anesthetic was developed in the latter half of the 19th century (topical cocaine), in recent years, safer and more effective agents have become available. One of the first topical creams developed, TAC (tetracaine, adrenalin, cocaine), also contained cocaine, so it is rarely used any more. Fortunately, LET/LAT (lidocaine, epinephrine/adrenalin, tetracaine) solution-gel has been found to be as effective as TAC. LET eliminates cocaine, thereby lessening the risk for toxicity and seizures, decreasing documentation issues, and lowering the cost.

EMLA (eutectic mixture of local anesthetics), first approved by the U.S. Food and Drug Administration (FDA) in 1992, is now one of the most widely used. A *eutectic mixture* is one in which the melting point of the mixture is lower than that of the individual components; in the case of EMLA, the components (lidocaine and prilocaine) remain liquid at room temperature. LMX 4 (4% liposomal lidocaine) and LMX 5 (5% liposomal lidocaine) are liposomal agents available over the counter. LMX 4 and LMX 5 were formerly called ELA-Max. Liposomes are synthetic biologic membranes composed of an aqueous core surrounded by a lipid layer. This delivery system allows medications to penetrate the stratum corneum more readily because they resemble cell membranes. Consequently, the onset of action is enhanced while, at the same time, the duration of action is lengthened because the lysosomal encapsulation slows metabolism.

More recently, the S-Caine Patch has been developed. This 1:1 eutectic mixture of 70 mg lidocaine and 70 mg tetracaine has a disposable, oxygen-activated heating element incorporated into a patch that enhances anesthetic delivery. This heating element maintains the temperature at 39°C to 41°C for a 2-hour period, excellent for the delivery of topical anesthetic. S-Caine Peel has also been developed which conforms to every surface, hardens, and then can be peeled away prior to a procedure.

Categories of topical anesthetics include those applied to intact skin, to nonintact skin, or alternatively, to mucous membranes. These are important differences; for instance, a topical anesthetic (e.g., lidocaine) applied to the mucous membranes (e.g., nose, mouth, throat, tracheobronchial tree, esophagus, genitourinary tract) may result in significant absorption, resulting in blood levels comparable with those achieved with parenteral administration (Table 4.1). Therefore precautions should be taken against toxicity, especially in children. Available topical anesthetics for intact skin are EMLA/EMLA Disc, LMX 4, LMX 5, S-Caine, S-Caine Peel, and iontophoretic preparations. LMX 5 was designed to be used on rectal mucosa. Lidocaine gel at varying concentrations has also been developed for nonintact skin and mucous membranes. Versions of benzocaine (HurriCaine, Americaine, Cetacaine) at varying concentrations and flavors have been designed for application to mucous membranes. Meanwhile, as more aesthetic procedures have been developed and performed, clinicians have started using various compounded mixtures (see below and Chapter 50).

In addition to creams and ointments, cooling can also be used to provide brief, temporary anesthesia (e.g., ethyl chloride spray or ice cubes). Handheld jet injectors are also available that use high pressure to deliver lidocaine through a very small orifice and across intact skin (see Fig. 111.5 and Chapter 111).

INDICATIONS

Intact Skin

Eutectic Mixture of Local Anesthetics

- FDA: for use on intact skin for local anesthesia and for genital mucous membranes for superficial surgery and pretreatment for infiltrative anesthesia.

LMX 4/LMX 5

- LMX 4: Manufacturer label: temporary relief of pain associated with minor cuts, abrasions, minor burns, skin irritation, and insect bites.
- LMX 5: Manufacturer label: hemorrhoids.
- Literature-supported uses of LMX: venipuncture, venous cannulation, arterial puncture, suture removal, shave biopsy, punch biopsy, chemical peels, curettage of molluscum contagiosum, cryotherapy of venereal warts, intracutaneous allergy testing, epilation, debridement of otitis media with an intact tympanic membrane, removal of an embedded foreign body, circumcision at more than a 37-week gestation, skin grafting, debridement of ulcers, lumbar puncture.
- Adjunct to: vasectomy, dermabrasion, laser resurfacing, postsurgical discomfort.
- Nonsurgical uses: postherpetic neuralgia, meralgia paresthetica.
- When used for intact skin, efficacy is similar to EMLA, but LMX 4 is less expensive. Injected buffered lidocaine appears to provide superior anesthesia to LMX 4 for intravenous catheter insertion.

Lidoderm Patch

FDA: relief of pain associated with postherpetic neuralgia.

BLT Triple Anesthetic Gel (20% Benzocaine, 6% Lidocaine, 4% Tetracaine)

- Used for intact skin.
- Percentages may vary.
- This is usually compounded.

TABLE 4.1 Summary of Topical Anesthetics

Agents	Concentration	Status	Maximum Dose or Area*	Onset of Action	Duration	Pregnancy Category†
Intact Skin						
EMLA cream or anesthetic disc	2.5% lidocaine/2.5% prilocaine	Rx	20 g/200 cm^2 for 7–12 yr of age and >20 kg (A) and (C)	60–120 min	180 min	B
LMX 4/5	4% lidocaine plus vitamin E, propylene glycol, benzyl alcohol, lecithin, cholesterol, carbomer-940, triethanolamine, polysorbate 80	OTC	100 cm^2 (A)	‡	‡	B
Amethocaine gel	4% tetracaine	Europe	50 mg (A)	40 min	240 min	C
Lidocaine acid mantle (Novartis)	30%–40% lidocaine	Rx		20 min	30–60 min	
Patch (Lidoderm)	5% lidocaine	Rx	420 cm^2 (three patches)		12 hr max duration of patch time	B (patch not studied in pregnancy)
S-Caine Patch/Peel	Lidocaine 70 mg, tetracaine 70 mg	Rx	One patch	30 min	Patch time	
BLT gel	20% benzocaine, 6% lidocaine, 4% tetracaine			15 min	60 min	C
Ethyl chloride spray	Skin refrigerant	OTC		<1 min	Transient	
Topicaine	4%–5% lidocaine	OTC	600 cm^2 (A), 100 cm^2 (C >10 kg)	Rapid	30–60 min	
Nonintact Skin						
LET/LAT	4% lidocaine/1:2000 epinephrine/1% tetracaine	Compounded				
Mucous Membrane						
Xylocaine		Rx	300 mg (A)/100 mg (C)	2–5 min	15–45 min	B
Viscous solution	2% lidocaine			1–2 min	15–20 min	
Liquid	5% lidocaine			2 min		
Ointment	2.5%, 5% lidocaine					
Benzocaine						
Cetacaine						
spray	14% benzocaine	Rx				
liquid	2% tetracaine	Rx				
gel						
ointment						
HurriCaine						
liquid	20% benzocaine	OTC		<5 min	15–45 min	C
gel						
spray						
Cocaine solution	4% and 10%	C-II§	200 mg (A)	1–5 min	30–60 min	C
Ophthalmic						
Alcaine solution	0.5% proparacaine	Rx		20 sec	15–20 min	C
Pontocaine solution	0.5% tetracaine	Rx	50 mg (A)	20 sec	15–20 min	C

*A, Adults; C, children.
†Pregnancy category B: Animal studies have not shown a fetal risk but there are no controlled studies in pregnant women. Pregnancy category C: Animal studies are not available. Safety for use during pregnancy has not been established. Use only when potential benefits outweigh potential hazards to the fetus.
‡No clinical studies.
§C-II: Controlled substances schedule II drug (Controlled Substances Act of 1970). Cocaine must be stored in a locked cabinet; and separate written records must be maintained for a period of 2 years after the drug is dispensed.
EMLA, Eutectic mixture of local anesthetics; *LAT,* lidocaine, adrenalin, tetracaine; *LET,* lidocaine, epinephrine, tetracaine; *OTC,* over the counter; *Rx,* prescription; *TAC,* tetracaine, adrenalin, cocaine.
Modified from Huang W, Vidimos A. Topical anesthetics in dermatology. *J Am Acad Dermatol*. 2000;43:286–298.

S-Caine Patch/S-Caine Peel

- Used for intact skin.
- Approved for children 3 years of age or older.

Nonintact Skin

Topicaine (4% or 5% Lidocaine Gel), Benzocaine Spray

- Minor skin cuts or abrasions.
- Available over the counter.

LET/LAT (Lidocaine, Epinephrine/Adrenalin, Tetracaine)

- Scalp and facial lacerations (LET seems to be less effective on the trunk and extremities).
- Does not work on intact skin.
- Works especially well in young children with wound less than 5 cm in length. In theory, leaving the wound open longer while waiting for anesthesia to take effect may increase the risk of wound infection.
- Some institutions still use cocaine in this mixture (lidocaine, adrenaline, cocaine), but most complications with this technique were associated with mixtures that contain cocaine.

LMX 4

- LMX 4: Manufacturer label: temporary relief of pain associated with minor cuts, abrasions, minor burns, skin irritation, and insect bites.

Mucous Membranes (e.g., nose, mouth, throat, tracheobronchial tree, esophagus, genitourinary tract)

Lidocaine (Xylocaine), Benzocaine, Tetracaine, Cocaine

- Painful, irritated, inflamed mucous membranes; anesthesia before minor surgical procedure and esophagogastroduodenoscopy.
- 2% viscous lidocaine for aphthous ulcers and mucositis in immunosuppressed patients.

Ophthalmic Preparations

- Proparacaine seems to burn less than tetracaine.
- Removal of foreign bodies, short eyelid procedures (e.g., chalazion removal), and placement of eye shields.

Mechanical Methods

Thermal: Ice/Ethyl Chloride Spray

Skin tag clipping, incision and drainage of simple abscess, and injections (blood draws, skin grafting, sports injuries).

Jet injectors: see Fig. 111.5, and Chapter 111.

For Aesthetic Procedures

Many noninvasive aesthetic procedures (e.g., deep skin peels, facial resurfacing) require some type of topical anesthetic. Oral analgesic medications and anxiolytics can also be beneficial. Everyone seems to have his or her own favorite compounded preparation. With the rapid growth of procedures in this field, few studies have been published to compare the various combinations and their efficacy.

BLT (Benzocaine, Lidocaine, Tetracaine) Triple Anesthetic Gel

BLT is a favorite compounded mixture. The percentages may vary (e.g., 20%, 7%, 7%; or 20%, 6%, 4%). With most BLT preparations, it takes 45 to 60 minutes to obtain good effect.

Quadri-Caine

Quadri-Caine (compounding pharmacies listed in "Suppliers" section) is a compounded topical anesthetic that has a more rapid onset (10 to 15 minutes). Standard Quadri-Caine consists of 10% lidocaine, 5% tetracaine, 5% prilocaine, and 1% bupivacaine in an emollient cream plus a penetration enhancer. Quadri-Caine VC contains the vasoconstrictor phenylephrine.

Quadri-Caine, as with most of these potent compounded preparations, should be used only under the direction of clinicians experienced in the use of high-potency topical anesthetics. It is unknown what amounts of the topical anesthetics in Quadri-Caine reach the systemic circulation. The amount to apply must be determined on a case-by-case basis. It is recommended that not more than 3 g of Quadri-Caine be applied in 24 hours.

Quadri-Caine is not for resale. It must be purchased by a medical office or clinic for use during a patient visit or may be ordered by prescription specifically for individual patient use. Quadri-Caine and Quadri-Caine VC are registered trademarks and, as compounded products, have not undergone FDA review.

NOTE: Compounded products are not produced under the same standards as FDA-approved products. The levels of lidocaine may vary dramatically, and toxicity studies using moderate or large amounts of compounded products have not been performed. One of the editors had a patient with delayed (2 hours following procedure) severe headache and significantly elevated systolic blood pressures (up to 260 mm Hg) following a laser procedure. This patient had been premedicated with topical compounded Quadri-Caine containing phenylephrine. Whether this was an idiosyncratic event or not, this editor no longer uses the Quadri-Caine VC, and in fact, now prefers BLT to Quadri-Caine.

BOX 4.1 Agents Associated With Methemoglobinemia

Acetaminophen
Acetanilid
Aniline dyes
Benzocaine
Chloroquine
Dapsone
Naphthalene
Nitrates and nitrites
Nitrofurantoin
Nitroglycerin
Nitroprusside
Pamaquine
Para-aminosalicylic acid
Phenacetin
Phenobarbital
Phenytoin
Primaquine
Quinine
Sulfonamides

Use with caution with eutectic mixture of local anesthetics (EMLA).
From Huang W, Vidimos A. Topical anesthetics in dermatology. *J Am Acad Dermatol.* 2000;43:286–298.

CONTRAINDICATIONS

Most of the preparations are contraindicated in pregnancy and for women who are breast feeding. Many preparations contain preservatives that can cause allergic reactions. If a patient develops an allergic dermatitis while using a topical anesthetic, he or she may not be allergic to the active drug itself, but rather to other components in the cream or ointment. An allergy to lidocaine is extremely rare, if it occurs at all.

LET/LAT

Sensitivity to tetracaine, epinephrine, or lidocaine

Eutectic Mixture of Local Anesthetics

- Advanced liver disease (hepatic metabolism)
- Methemoglobinemia risk

LMX 4/LMX 5

- Sensitivity to lidocaine
- Avoid mucous membranes: absorption increases toxicity risks, especially in children
- Efficacy diminishes as the skin thickness (lack of absorption) and vascularity (rapid clearance) increases. Essentially ineffective on the palms and soles even if occluded for hours.

Lidoderm 5% Patch

- Sensitivity to lidocaine (rare); denuded skin; mucous membranes
- Do not use more than 12 hours out of 24-hour period to avoid toxicity. Do not use with methemoglobinemia-inducing agents on infants younger than 12 months of age (Box 4.1).
- Use with caution in infants younger than 3 months of age (maximum dose of 1 g for 1-hour application if term).

BLT Triple Anesthetic Gel

- Allergy to p-aminobenzoic acid, hair dyes, and sulfonamides
- Sensitivity to benzocaine, lidocaine, or tetracaine

S-Caine Patch/S-Caine Peel

Sensitivity to lidocaine or tetracaine

Topicaine (4% to 5% Lidocaine Gel)

Sensitivity to lidocaine

Thermal: Ice/Ethyl Chloride Spray

- Raynaud phenomenon, cryoglobulinemia
- Not effective for skin biopsy, alters specimen

Lidocaine (Xylocaine), Benzocaine (Mucous Membranes)

- Sensitivity to lidocaine or benzocaine

Ophthalmic Preparations

- Not to be used to control pain over long term
- Inhibits healing and, because no sensation, may lead to inadvertent trauma
- May also eliminate blinking, leading to drying of cornea

TECHNIQUE

NOTE: Precautions must be taken to avoid high blood levels of anesthetics. This is especially true with the use of compounded products or FDA-approved products used under occlusion. Part of the confusion that providers face relates to the need to use occlusion with EMLA because of its poor penetration through the stratum corneum. With LMX 4/LMX 5, occlusion is not needed because the liposomes appear to enhance absorption. However, clinicians may accidently or purposely use these newer agents under occlusion. Small doses of these drugs have been shown to be safe when used with occlusion, but large doses (>60 g) may be toxic.

INTACT SKIN

Eutectic Mixture of Local Anesthetics /Eutectic Mixture of Local Anesthetics Disc

EMLA cream is a eutectic or liquid mixture of 2.5% lidocaine and 2.5% prilocaine. To use, first remove oil from skin with an alcohol or acetone swab. Consider thinning the stratum corneum through tape stripping of superficial cells. Apply the disc or 1 to 2 g per 10 cm^2 of the cream. Cover with an occlusive dressing (Tegaderm, Opsite, or Band-Aid) for 60 minutes for a 3-mm depth. Every additional 30 minutes provide 1 mm of more depth; a 2-hour maximum time is equivalent to 5 mm. Cream should still be visible when the dressing is removed. If it is not visible, an inadequate amount was used (Table 4.2).

LMX 4/LMX 5

Apply for 15 to 40 minutes without occlusion. A transient erythema may develop, but no serious side effects have been observed. In children weighing less than 20 kg, apply cream to an area no larger than 100 cm^2 to prevent systemic toxicity.

TABLE 4.2 Recommended Maximum Dose and Application Area of Eutectic Mixture of Local Anesthetics

Age	Body Weight (kg)	Maximum Total Dose and Time	Maximum Application Area (cm^2)
1–3 mo	<5	1 g (1 hr)	10
4–12 mo	>5	2 g (4 hr)	20
1–6 yr	>10	10 g (4 hr)	100
7–12 yr	>20	20 g (4 hr)	200

Modified from Huang W, Vidimos A. Topical anesthetics in dermatology. *J Am Acad Dermatol*. 2000;43:286–298.

Lidoderm 5% Patch

Apply up to three patches at one time to cover the most painful area (e.g., postherpetic neuralgia) for a maximum of 12 hours in a 24-hour period. Patches may be cut to smaller sizes for smaller lesions or impaired elimination (e.g., hepatic disease).

BLT Triple Anesthetic Gel

Apply to intact skin for 10 to 30 minutes. Recent studies note that BLT provides effective analgesia after 15 minutes of application.

S-Caine Patch/S-Caine Peel

Apply S-Caine Patch and use disposable heating element as instructed. Time to effect is 20 to 30 minutes.

Apply S-Caine Peel to area. The cream dries on exposure to air and becomes flexible and is peeled off skin after 20 to 30 minutes. The advantage of this flexible membrane is delivery of topical anesthetic to contoured areas of the body. Do not leave on longer than 30 minutes.

Topicaine

Apply a moderately thick layer (about one-eighth inch) to affected area. Best anesthetic results occur in 20 minutes to 1 hour.

Nonintact Skin

LET/LAT

The facial or scalp laceration should first be placed in a gravity-dependent position. Apply 1.5 to 3.0 mL of LET (or comparable solution) to a soaked gauze and wipe in and over the wound. Alternatively, LET can be poured into the wound and then a LET-soaked gauze or cotton ball applied after 3 minutes. Avoid mucous membranes and end-arteriolar parts of the body such as the digits. Tape or hold the pad in place firmly. Contact with wound should be for a minimum of 15 minutes and a maximum of 30 minutes. Watch for blanching, which correlates with anesthesia. Onset of action is 15 to 30 minutes. LET gel preparations have been found to be as effective as LET solutions, and do not require the gauze or cotton ball pad to be held in place afterward. The gel solutions usually provide more uniform application to tissues, possibly providing better anesthetic effect. Again, it is important to avoid mucous membrane absorption which could result in systemic toxicity, especially in children; fatalities have been reported.

Mucous Membranes

Lidocaine (Xylocaine), Benzocaine, Tetracaine (Mucous Membranes)

Wolfe and colleagues reported in 2000 that atomized lidocaine 4% solution decreased the discomfort of nasogastric tube placement.

The combination of 1.5 mL atomized lidocaine applied intranasally plus 3.0 mL applied oropharyngeally plus 5 mL 2% lidocaine jelly applied intranasally is superior to jelly alone. Caution should be used because of impaired swallowing after use. Patients should expectorate excess anesthetic to avoid systemic absorption and toxicity. Plasma levels are similar to those obtained with intravenous injection. For viscous solution, do not exceed one tablespoon (15 mL) every 3 hours or one teaspoon (5 mL) of 5% liquid in an adult (see Chapters 5 and 6 for maximum doses). Ingestion of food should be avoided for at least 1 hour after oral use to prevent aspiration.

Magic mouthwash contains diphenhydramine elixir, Maalox, and 2% viscous lidocaine and is often used for aphthous ulcers or stomatitis. Anbesol is a popular over-the-counter benzocaine preparation used for dental pain. HurriCaine/Americaine/Cetacaine spray is useful for many oral procedures. It is available in various flavors, requires a prescription, and contains benzocaine. Another compounded formula used for mucous membranes contains lidocaine, prilocaine, and tetracaine (Profound, Steven's Pharmacy).

Thermal: Ice/Ethyl Chloride Spray

For skin-tag clipping hold ice in direct contact for 10 seconds and clip skin tag immediately. For draining an abscess, spray the vaporized coolant for 1 to 2 seconds until the dermis turns white and immediately drain the abscess. Use caution because overapplication causes blistering. Use of thermal cooling may also lessen pain from injections.

Ophthalmic Use

Apply one or two drops in the eye. The effects of the anesthetic are rapid (30 seconds) and persist up to 15 minutes. An additional drop can be placed every 5 to 10 minutes for a total of 7 to 10 drops. Patients should not be discharged with topical ophthalmics unless they are going to be examined daily by the clinician for a worsening condition.

Conclusion

Topical anesthetics may offer a painless alternative to painful injectable anesthetics. Since the advent of TAC, there have been numerous advances. EMLA cream and over-the-counter LMX are now available. Moreover, advances in delivery modes, including heat in S-Caine Patch and flexible membranes in S-Caine Peel, allow the provider to tailor topical anesthetics to specific clinical situations. Compounded products (Quadri-Caine, BLT) have further enhanced topical anesthetics.

Acknowledgment

The editors recognize the contributions of William Dery, MD, to this chapter in a previous edition of this text.

Suppliers

(See contact information available at www.expertconsult.com.)

BLT Topical Anesthesia (compounded benzocaine, lidocaine, tetracaine)
Biosense Clinic

Quadri-Caine Topical Anesthesia (compounded bupivacaine, lidocaine, prilocaine, tetracaine)
Keystone Pharmacy (compounding pharmacy)
Portage Pharmacy
Scripts Pharmacy (compounding pharmacy)

Profound (compounded lidocaine, prilocaine, tetracaine)
Steven's Pharmacy

Recommended Reading

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CHAPTER 5

LOCAL ANESTHESIA

Gerald A. Amundsen

The administration of local anesthesia is important for many clinical settings. Most wounds, traumatic and surgical, require some form of anesthesia before repair to maintain patient comfort and satisfaction. More than 100 million wounds are repaired in the United States each year, so it is important for most clinicians to be comfortable with the medications and techniques used to administer the medications.

The action of local anesthetics at the molecular level is to prevent the generation and conduction of nerve impulses. The overall effect of an anesthetic is to reduce pain associated with trauma or procedures; this effect in turn depends on such factors as blood supply, the size of the area to be anesthetized, and the location of the wound in terms of nerve ending size and density. The fingers, toes, genitals, perianal area, and nose are especially sensitive. Patient factors such as infection, anxiety, and chronic disease (e.g., diabetes, peripheral vascular disease, obesity) also affect the success of the anesthetic. To achieve successful anesthesia, the clinician must be able to make decisions about dose and route of administration while also considering these factors (also see Chapter 4).

INDICATIONS

- To relieve pain from a procedure (incision) or trauma (laceration/fracture)
- Diagnostic nerve blocks to isolate pathology

See Tables 5.1 and 5.2 for a selection of local anesthetics and their characteristics, and Box 5.1 for selection criteria for local anesthetics.

CONTRAINDICATIONS

- "Known" sensitivity to amide anesthetic medications (lidocaine, mepivacaine, bupivacaine) is very rare. The older ester anesthetics (procaine, tetracaine) are more likely to cause true allergic reactions. Fortunately, there is no cross-reactivity between the classes, so the individual with known sensitivity to the ester anesthetics is not likely to experience a reaction with the amide group. The **parabens preservatives** used to prolong shelf life in multidose vials of amide anesthetics may induce sensitivity reactions similar to those of the ester group. Parabens are most likely the cause of any "allergy" ascribed to the amides. However, the incidence of parabens allergy is also quite low. If there is a concern about an allergy, use single-dose vials of the amide anesthetics that lack a preservative and are inexpensive. Other considerations include use of a diphenhydramine (1%) or benzyl alcohol (0.9%) mixture as an alternative injectable anesthetic (see below). Knowing that amide allergy is very rare, one expert has also proposed skin testing by using a 0.1 mL of intradermally administered lidocaine as a skin test. However, other experts suggest that intradermal placement can produce false responses, so they recommend subcutaneous injection of this dose while exercising due caution in the unlikely event that the patient exhibits a serious reaction. If no reaction occurs in 30 minutes, consider proceeding with the full dose.
- History of central nervous system symptoms (e.g., seizure, tremor, tinnitus) associated with anesthetic toxicity (relative contraindication).
- History of cardiovascular reactions (e.g., hypotension, bradyarrhythmia) associated with previous anesthetic use (relative contraindication).
- Epinephrine, frequently used in local anesthetics to prolong the action as well as to decrease the blood flow, may cause a variety of reactions either directly, in association with other medications the patient uses, or as a result of other existing comorbidities.
- While in the past it was generally recommended that epinephrine be avoided because of vasoconstrictive properties, in the distal extremities (i.e., fingers, toes, penis, nose, earlobes), reports of skin ischemia or sloughing in these situations had generally been observed when concentrations of 1:20,000 were used. Current practice generally uses concentrations in the range of 1:100,000 to 1:200,000. Several experts, supported by studies, suggest that epinephrine at these doses can be safely used in the fingers and toes without adverse sequelae.
- Patients with known peripheral vascular disease may have an exaggerated vasoconstrictor response to epinephrine. Extreme care should be taken if local anesthetics with vasoconstrictors are used in patients with diabetes, hypertension, arteriosclerosis, thyrotoxicosis, heart block, or cerebral vascular disease.
- If a skin flap has marginal viability or if blood flow to a flap is compromised, epinephrine should not be used.
- If a wound is contaminated, epinephrine may increase the likelihood of infection because of the diminished blood flow.
- Do not use epinephrine in patient taking monoamine oxidase inhibitors.

EQUIPMENT

Supplies necessary for the local administration of anesthetic are typically inexpensive and readily accessible.

- Anesthetic agents of choice (see Table 5.1 and Box 5.1)
- 18-gauge needle to draw up solution
- 25- to 30-gauge needles of various lengths
- Syringes (1 to 10 mL)
- Antiseptic (alcohol, povidone-iodine, chlorhexidine) to clean the vial top and the clinical area
- Sodium bicarbonate 7.5% (Neutra-Caine) or sodium bicarbonate 7% to 10% for buffering the anesthetic (e.g., lidocaine or mepivacaine) if desired to reduce the pain of injection (see later discussion; also bupivacaine can be buffered, but to avoid precipitation, lower amounts of sodium bicarbonate should be used)

EDITOR'S NOTES: (1) When equipping the office, it is not necessary to store every type of anesthetic at every concentration, and it is also not necessary to stock the office with every size and length of needle.