Chapter

2 LEARNING ANESTHESIA

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The challenges of learning perioperative anesthesia care have grown considerably as the specialty, and medicine in general, have evolved. The beginning anesthesia trainee is faced with an ever-increasing quantity of knowledge, the need for adequate patient care experiences, and increased attention to patient safety as well as cost containment.[1] Most training programs begin with close clinical supervision by an attending anesthesiologist. More experienced trainees may offer their perspectives and practical advice. Some programs use a mannequin-based patient simulator or other forms of simulation to facilitate the learning process.[2] The practice of anesthesia involves the development of flexible patient care routines, factual and theoretical knowledge, manual and procedural skills, and the mental abilities to adapt to changing situations.[3]

COMPETENCIES AND MILESTONES

The anesthesia provider must be skilled in many areas. The Accreditation Council for Graduate Medical Education (ACGME) developed its Outcome Project, which includes a focus on six core competencies: patient care, medical knowledge, professionalism, interpersonal and communication skills, systems-based practice, and practice-based learning and improvement (Table 2.1).[4] More recently, the ACGME has advanced the core competencies approach by adopting the Dreyfus model of skill acquisition to create a framework of "milestones" in the development of anesthesia residents during 4 years of training.[5,6] Table 2.2 shows an example of a milestone in the patient care competency. The milestones incorporate several aspects of residency training, including a description of expected behavior, the complexity of the patient and the surgical procedure, and the level of supervision needed by the resident.

Table 2.1 Competencies in Anesthesia Care

Procedure Event/ Problem	Competency
Perform preoperative history and physical	Patient care, communication
Determine dose of neuromuscular blocking drug to facilitate tracheal intubation	Medical knowledge
Perform laryngoscopy and tracheal intubation	Patient care
Interact with surgeons and nurses in operating room	Professionalism, communication
Manage maintenance and emergence from anesthesia	Patient care
Patient with dental injury: refer to quality assurance committee	Systems-based practice
Patient with postoperative nausea: compare prophylaxis strategy with published literature	Practice-based learning and improvement

STRUCTURED APPROACH TO ANESTHESIA CARE

Anesthesia providers care for the surgical patient in the preoperative, intraoperative, and postoperative periods (Box 2.1). Important patient care decisions reflect on assessing the preoperative evaluation, creating the anesthesia plan, preparing the operating room, and managing the intraoperative anesthetic, postoperative care, and outcome. An understanding of this framework will facilitate the learning process.

Preoperative Evaluation

The goals of preoperative evaluation include assessing the risk of coexisting diseases, modifying risks, addressing patients' concerns, and discussing options for anesthesia care (see Chapters 13 and 14). The beginning trainee should learn the types of questions that are the most important to understanding the patient and the proposed surgery. Some specific questions and their potential importance follow.

What is the indication for the proposed surgery? Is it elective or an emergency? The indication for surgery may have particular anesthetic implications. For example,

Table 2.2 Example of Anesthesia Resident Milestones: Patient Care Competency, Anesthetic Plan, and Conduct

Level 1	Level 2	Level 3	Level 4	Level 5
Formulates patient care plans that include consideration of underlying clinical conditions, past medical history, and patient, medical, or surgical risk factors Adapts to new settings for delivery of patient care	Formulates anesthetic plans for *patients undergoing routine procedures* that include consideration of underlying clinical conditions, past medical history, patient, anesthetic and surgical risk factors, and patient choice Conducts *routine* anesthetics, including management of commonly encountered physiologic alterations associated with anesthetic care, with *indirect supervision*	Formulates anesthetic plans for *patients undergoing common subspecialty procedures* that include consideration of medical, anesthetic, and surgical risk factors and that take into consideration a patient's anesthetic preference Conducts *subspecialty* anesthetics with *indirect supervision* but may require *direct supervision for more complex* procedures and patients	Formulates and tailors anesthetic plans that include consideration of medical, anesthetic, and surgical risk factors and patient preference for *patients with complex medical issues undergoing complex procedures with conditional independence* Conducts *complex* anesthetics with *conditional independence; may supervise others* in the management of complex clinical problems	*Independently* formulates anesthetic plans that include consideration of medical, anesthetic, and surgical risk factors as well as patient preference for *complex patients and procedures* Conducts *complex* anesthetic management *independently*

Levels correspond to the following time points during residency:
Level 1: Resident has completed one postgraduate year of education.
Level 2: Resident is without significant experience in subspecialties of anesthesiology.
Level 3: Resident has experience in subspecialties of anesthesiology.
Level 4: Resident substantially fulfills milestones expected of an anesthesiology residency; designated as graduation target.
Level 5: Resident has advanced beyond performance targets defined for residency and is demonstrating "aspirational" goals.
From Anesthesiology Residency Review Committee. The Anesthesiology Milestone Project. https://www.acgme.org/Portals/0/PDFs/Milestones/AnesthesiologyMilestones.pdf. July 2015. Accessed May 2, 2016.

Box 2.1 Phases of Anesthesia Care

Preoperative Phase
Preoperative evaluation
Choice of anesthesia
Premedication

Intraoperative Phase
Physiologic monitoring and vascular access
General anesthesia (i.e., plan for induction, maintenance, and emergence)
Regional anesthesia (i.e., plan for type of block, needle, local anesthetic)

Postoperative Phase
Postoperative pain control method
Special monitoring or treatment based on surgery or anesthetic course
Disposition (e.g., home, postanesthesia care unit, ward, monitored ward, step-down unit, intensive care unit)
Follow-up (anesthesia complications, patient outcome)

a patient requiring esophageal fundoplication will likely have severe gastroesophageal reflux disease, which may require modification of the anesthesia plan (e.g., preoperative nonparticulate antacid, intraoperative rapid-sequence induction of anesthesia).

A given procedure may also have implications for anesthetic choice. Anesthesia for hand surgery, for example, can be accomplished with local anesthesia, peripheral nerve blockade, general anesthesia, or sometimes a combination of techniques. The urgency of a given procedure (e.g., acute appendicitis) may preclude lengthy delay of the surgery for additional testing, without increasing the risk of complications (e.g., appendiceal rupture, peritonitis).

What are the inherent risks of this surgery? Surgical procedures have different inherent risks. For example, a patient undergoing coronary artery bypass graft has a significant risk of problems such as death, stroke, or myocardial infarction. A patient undergoing cataract extraction has an infrequent risk of major organ damage.

Does the patient have coexisting medical problems? Does the surgery or anesthesia care plan need to be modified because of them? To anticipate the effects of a given medical problem, the anesthesia provider must understand the physiologic effects of the surgery and anesthetic and the potential interaction with the medical problem. For example, a patient with poorly controlled systemic hypertension is more likely to have an exaggerated hypertensive response to direct laryngoscopy to facilitate tracheal intubation. The anesthesia provider may change the anesthetic plan to increase the induction dose of intravenously administered anesthetic (e.g., propofol) and administer a short-acting β-adrenergic blocker (e.g., esmolol) before instrumentation of the airway. Depending on the medical problem, the anesthesia plan may require modification during any phase of the procedure.

Has the patient had anesthesia before? Were there complications such as difficult airway management? Does the patient have risk factors for difficult airway management? Anesthesia records from previous surgery can yield much useful information. The most important fact is the ease of airway management techniques such as direct laryngoscopy. If physical examination reveals some risk factors for difficult tracheal intubation, but the patient had a clearly documented uncomplicated direct laryngoscopy for recent surgery, the anesthesia provider may choose to proceed with routine laryngoscopy. Other useful historical information includes intraoperative hemodynamic and respiratory instability and occurrence of postoperative nausea.

Creating the Anesthesia Plan

After the preoperative evaluation, the anesthesia plan can be completed. The plan should list drug choices and doses in detail, as well as anticipated problems (Boxes 2.2 and 2.3). Many variations on a given plan may be acceptable, but the trainee and the supervising anesthesia provider should agree in advance on the details.

Preparing the Operating Room

After determining the anesthesia plan, the trainee must prepare the operating room (Table 2.3). Routine operating room preparation includes tasks such as checking the anesthesia machine (see Chapter 15). The specific anesthesia plan may have implications for preparing additional equipment. For example, fiberoptic tracheal intubation requires special equipment that may be kept in a cart dedicated to difficult airway management.

Managing the Intraoperative Anesthetic

Intraoperative anesthesia management generally follows the anesthesia plan but should be adjusted based on the patient's responses to anesthesia and surgery. The anesthesia provider must evaluate a number of different information pathways from which a decision on whether to change the patient's management can be made. The trainee must learn to process these different information sources and attend to multiple tasks simultaneously. The general cycle of mental activity involves observation, decision making, action, and repeat evaluation. Vigilance—being watchful and alert—is necessary for safe patient care, but vigilance alone is not enough. The anesthesia provider must weigh the significance of each observation and can become overwhelmed by the amount of information or by rapidly changing information. Intraoperative clinical events can stimulate thinking and promote an interactive discussion between the trainee and supervisor (Table 2.4).

Box 2.2 Sample General Anesthesia Plan

Case
A 47-year-old woman with biliary colic and well-controlled asthma requires anesthesia for laparoscopic cholecystectomy.

Preoperative Phase
Premedication:
Midazolam, 1-2 mg intravenous (IV), to reduce anxiety
Albuterol, two puffs, to prevent bronchospasm

Intraoperative Phase
Vascular Access and Monitoring
Vascular access: one peripheral IV catheter
Monitors: pulse oximetry, capnography, electrocardiogram, noninvasive blood pressure with standard adult cuff size, temperature

Induction
Propofol, 2 mg/kg IV (may precede with lidocaine, 1 mg/kg IV)
Neuromuscular blocking drug to facilitate tracheal intubation (succinylcholine, 1-2 mg/kg IV) or nondepolarizing neuromuscular blocking drugs (rocuronium, 0.6 mg/kg)
Airway management
Face mask: adult medium size
Direct laryngoscopy: Macintosh 3 blade, 7.0-mm internal diameter (ID) endotracheal tube

Maintenance
Inhaled anesthetic: sevoflurane or desflurane
Opioid: fentanyl, anticipate 2-4 μg/kg IV total during procedure
Neuromuscular blocking drug titrated to train-of-four monitor (peripheral nerve stimulator) at the ulnar nerve[a]

Emergence
Antagonize effects of nondepolarizing neuromuscular blocking drug: neostigmine, 70 μg/kg, and glycopyrrolate, 14 μg/kg IV, titrated to train-of-four monitor
Antiemetic: dexamethasone, 4 mg IV, at start of procedure; ondansetron, 4 mg IV, at end of procedure
Tracheal extubation: when patient is awake, breathing, and following commands
Possible intraoperative problem and approach:
Bronchospasm: increase inspired oxygen and inhaled anesthetic concentrations, decrease surgical stimulation if possible, administer albuterol through endotracheal tube (5-10 puffs), adjust ventilator to maximize expiratory flow

Postoperative Phase
Postoperative pain control: patient-controlled analgesia—hydromorphone, 0.2 mg IV; 6-min lockout interval, do not use basal rate
Disposition: postanesthesia care unit, then hospital ward

[a]Nondepolarizing neuromuscular blocking drug choices include rocuronium, vecuronium, pancuronium, atracurium, and cisatracurium.

Box 2.3 Sample Regional Anesthesia Plan

Case
A 27-year-old man requires diagnostic right shoulder arthroscopy for chronic pain. He has no known medical problems.

Preoperative Phase
Premedication: midazolam, 1-2 mg intravenous (IV), to reduce anxiety

Intraoperative Phase
Type of block: interscalene
Needle: 22-gauge short-bevel, 5 cm long
Local anesthetic: 1.5% mepivacaine, 25 mL
Ancillary equipment: ultrasound machine with linear transducer, sterile sheath, ultrasound gel
Technique: chlorhexidine skin preparation, localize nerve in posterior triangle of neck, use ultrasound to guide in-plane needle insertion, inject local anesthetic
Intraoperative sedation and analgesia:
Midazolam, 0.5-1 mg IV, given every 5-10 minutes as indicated
Fentanyl, 25-50 μg IV, given every 5-10 minutes as indicated

Postoperative Phase
Postoperative pain control: when block resolves, may treat with fentanyl, 25-50 μg IV, as needed
Disposition: postanesthesia care unit, then home

Patient Follow-up

The patient should be reassessed after recovery from anesthesia. This follow-up includes assessing general satisfaction with the anesthetic, as well as a review for complications such as dental injury, nausea, nerve injury, and intraoperative recall. There is increasing attention on the long-term impact of anesthesia, including the impact of "deep" levels of anesthesia, hypotension, and inhaled anesthetic dose on postoperative mortality rate.[7]

LEARNING STRATEGIES

Learning during supervised direct patient care is the foundation of clinical training. Because the scope of anesthesia practice is so broad (see Chapter 1) and the competencies trainees are required to master are diverse, direct patient care cannot be the only component of the teaching program. Other modalities include lectures, group discussions, simulations, and independent reading. Lectures can be efficient methods for transmitting large amounts of information. However, the lecture format is not conducive to large amounts of audience interaction. Group discussions are most effective when they are small (fewer than 12 participants) and interactive. Journal clubs, quality assurance conferences, and problem-based case discussions lend themselves to this format. A teaching method termed *the flipped classroom* can combine aspects of lectures and group discussions.[8] One popular approach to the flipped classroom involves use of an online video lecture that must be viewed prior to the class session. Class time involves discussions or other active learning modalities that are only effective if the trainee has viewed the material beforehand. Simulations can

Table 2.3 Operating Room Preparation

Components	Preparation Tasks/Supplies and Equipment
Basic Room Setup	
Suction (S)	Check that suction is connected, working, and near the head of the bed.
Oxygen (O)	Check oxygen supply pressures (pipeline of approximately 50 psi and E-cylinder of at least 2000 psi). Check anesthesia machine (do positive-pressure circuit test).
Airway (A)	Two laryngoscope blades and handles
	Two endotracheal tubes of different sizes (one with and one without a stylet)
	Two laryngeal mask airways (LMA 3 and LMA 4)
	Two oral airways
	Two nasal airways
	Lidocaine or K-Y jelly
	Bite block and tongue depressor
	Tape
Intravenous access (I)	Two catheter sizes
	1-mL syringe with 1% lidocaine
	Tourniquet, alcohol pads, gauze, plastic dressing, tape
Monitors (M)	Electrocardiographic pads
	Blood pressure cuff (correct size for patient)
	Pulse oximeter probe
	Capnography monitor (breathe into circuit to confirm function)
	Temperature probe
Daily Drugs to Prepare	
Premedicants	Midazolam, 2 mL at 1 mg/mL
Opioids	Fentanyl, 5 mL at 50 µg/mL
Induction drugs	Propofol, 20 mL at 10 mg/mL
	or
	Thiopental, 20 mL at 25 mg/mL
	Etomidate, 20 mL at 2 mg/mL
Neuromuscular blocking drugs	Succinylcholine, 10 mL at 20 mg/mL
	Rocuronium, 5 mL at 10 mg/mL
Vasopressors	Ephedrine, 10 mL at 5 mg/mL (dilute 50 mg/mL in 9 mL of saline)
	Phenylephrine, 10 mL at 100 µg/mL (dilute 10 mg in 100 mL of saline)
Avoiding Drug Errors	
Tips for prevention	Look twice at the source vial being used to prepare your drug.
	Some vials look alike, and some drug names sound the same. Always label your drugs as soon as they are prepared. Write the following on the label: drug name and concentration, date, time, your initials.
	Discard unlabeled syringes.
Conversion of % to mg/mL	Move decimal point one place to the right (1.0% = 10 mg/mL).
	By definition, 1% = 1 g/100 mL.
	1% lidocaine is 1000 mg/100 mL, or 10 mg/mL.
Conversion of 1:200,000	Memorize: 1:200,000 is 5 µg/mL (1:1000 is 1000 µg/mL or 1 mg/mL).

Table 2.4 Examples of Intraoperative Events to Discuss

Event	Questions to Consider	Possible Discussion Topics
Tachycardia after increase in surgical stimulation	Is the depth of anesthesia adequate? Could there be another cause for the tachycardia? Is the patient in sinus rhythm or could this be a primary arrhythmia?	Assessment of anesthetic depth Approaches to increasing depth of anesthesia Diagnosis of tachycardia
End-tidal CO_2 increases after laparoscopic insufflation	Is the patient having a potentially life-threatening complication of laparoscopy such as CO_2 embolism? What is the expected rise in end-tidal CO_2 with laparoscopic procedures? How should the mechanical ventilator settings be adjusted?	Complications of laparoscopy Mechanical ventilation modes Causes of intraoperative hypercarbia
Peripheral nerve stimulator indicates train-of-four 0/4 15 minutes prior to end of surgery	Is the nerve stimulator functioning properly? Is there a reason for prolonged neuromuscular blockade? Can the blockade be reversed safely?	Neuromuscular stimulation patterns Clinical implications of residual neuromuscular blockade Pharmacology of neuromuscular blockade reversal

take several forms: task-based simulators to practice discrete procedures such as laryngoscopy or intravenous catheter placement, mannequin-based simulators to recreate an intraoperative crisis such as malignant hyperthermia or cardiac arrest, and computer-based simulators designed to repetitively manage advanced cardiac life support algorithms. Independent reading should include basic textbooks and selected portions of comprehensive textbooks as well as anesthesia specialty journals and general medical journals.

The beginning trainee is typically focused on learning to care for one patient at a time, that is, case-based learning. When developing an individual anesthesia plan, the trainee should also set learning goals for a case. For example, the patient in Box 2.2 has a history of asthma and requires laparoscopic surgery. Several questions could become topics for directed reading before the case or discussion during the case. *What complications of laparoscopic surgery can present intraoperatively? What are the manifestations? How should they be treated? How will the severity of the patient's asthma be assessed? What if the patient had wheezing and dyspnea in the preoperative area?* Trainees should regularly reflect on their practice and on how they can improve their individual patient care and their institution's systems of patient care.

Learning Orientation Versus Performance Orientation

The trainee's approach to a learning challenge can be described as a "performance orientation" or a "learning orientation."[9] Trainees with a performance orientation have a goal of validating their abilities, while trainees with a learning orientation have the goal of increasing their mastery of the situation. Feedback is more likely to be viewed as beneficial for trainees with a learning orientation, while a trainee with a performance orientation is likely to view feedback as merely a mechanism to highlight an area of weakness. If the training setting is challenging and demanding, an individual with a strong learning orientation is more likely to thrive.

TEACHING ANESTHESIA

The role of residents as teachers is increasingly recognized as crucially important to the training of medical students.[10] Residents will spend a significant amount of their time in teaching activities, even early in their own training. Many specialties have developed curricula to address this teaching role, which has a positive impact on both resident and student. One published approach consists of a series of workshops focused on six teaching skills: giving feedback, teaching around the case, orienting a learner, teaching a skill, teaching at the bedside, and delivering a minilecture.[11]

A clinical teaching approach that has been well described in several specialties is called the *One-Minute Preceptor* model.[12] It describes five sequential steps that can be used to structure brief clinical encounters. Table 2.5 lists the steps and an example relevant to an anesthesia student clerkship.

Table 2.5 Example of One-Minute Preceptor Teaching Model in Anesthesia

You are working with a medical student on an anesthesia rotation. An otherwise healthy patient is receiving general anesthesia for laparoscopic cholecystectomy. After CO_2 insufflation and placement of the patient in Trendelenburg (head-down) position, the oxygen saturation decreases from 100% to 93%.

Steps in Teaching	Dialogue With Student
Step 1. Get a commitment	Why do you think the oxygen saturation is decreasing?
Step 2. Probe for supporting evidence	What findings suggest that the endotracheal tube position changed?
Step 3. Teach general rules	Discuss how to approach acute hypoxemia during general anesthesia.
Step 4. Reinforce what was done well	You astutely observed other signs of endobronchial intubation such as elevated peak airway pressure.
Step 5. Correct mistakes	In the future, you would not give empiric bronchodilator therapy unless there are more definitive signs of bronchospasm.

QUESTIONS OF THE DAY

1. What is a "milestone" in the context of anesthesia residency training?
2. How would you adapt the sample general anesthesia plan in Box 2.2 if the patient had poorly controlled asthma and required emergency laparoscopic appendectomy?
3. What are the components of the One-Minute Preceptor teaching model?
4. You are working with a new anesthesia learner. How could you use the structure of Table 2.4 to develop questions and discussion topics for the following event: a healthy patient develops hypotension after induction of anesthesia and tracheal intubation?

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