Anesthesiology Rotation Primer

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Getting Started

So, you're starting out on a new clinical rotation with an entirely new department, in a completely foreign setting, armed with some vague recollection about anesthetic drugs from lectures during your second year in medicine, yet almost completely clueless about anesthesiology. You know you've only been given two weeks for this rotation, and you're thinking it'll be impossible to truly understand all the principles of anesthesiology just from chatting with anesthesia residents and watching intubations. Is it going to be another "read-this-handbook-and-you'll-get-it" kind of ordeal? The sort that teaches you some useful stuff, but by the time it all starts to make sense, the rotation is over, leaving you with a fragmented picture of what we do but very little understanding of how we do it?

So how do you get the most out of it?

This guide was meant to provide a brief overview of what we do, how we do it, and why we do it for typical, uncomplicated cases—the kind of cases you are bound to see during your rotation. The information included here was not intended to be comprehensive or to be a do-it-yourself guide. Instead, it is meant to help you see the big picture in a one-sitting quick read, and a handy reference as you go along. With a basic understanding of anesthetic principles, it becomes easier to understand variations in techniques between anesthesiologists and among different scenarios. Investing some time to read through this primer will definitely make it much easier to either cruise through the rotation (for the "breezy rotator") or to learn more stimulating principles that may benefit you in the future (for the "lifelong learner").

So read on a bit, and hopefully you'll find your rotation quite enjoyable.

Content Outline

Preoperative Evaluation

Before any patient undergoes surgery, they have to be assessed. This preoperative evaluation serves several goals. During this meeting, certain key points in the patient's medical history and physical exam are identified to help determine whether further tests or consults are needed, and to uncover risk factors that can guide our choice of anesthesia plan. This is also the best time to establish patient rapport, educate the patient about the perioperative process, and obtain informed consent.

To achieve those goals, the preoperative evaluation is highly focused on three areas—Miller's Rule of Three's: the acute history, chronic history, and physical exam.

Acute History

1. Exercise Tolerance. How well can the patient's heart handle the stress of surgery and anesthesia? (In practice, a patient who can climb 2 flights of stairs without stopping has no increased perioperative cardiac risk.)

2. History of Present Illness. Has the patient been acutely ill? Has the patient been in a hospital, ER, or had surgery in the last 2 years? If so, for how long and why? (Details about previous admissions can help you understand disease severity, identify other risk factors, and help avoid potential problems patients may have had before, such as difficult airway management, adverse reactions, or post-op nausea.)

3. Last Primary Care Physician Visit. Has the patient been medically optimized to undergo the stress of surgery? (Poor medical follow-up may point to a need for further consults or evaluation.)

Chronic History

1. Medications and Allergies. Why is the patient using these medications? (This helps identify more underlying illnesses and risk factors. Also, several medications can influence choice of anesthetics.) Which medications were taken today? (Some, like antihypertensives, are best continued until the day of surgery, while others, like oral hypoglycemics, are avoided on the morning of surgery.)

2. Social History. Active smokers are at higher risk for airway hyperreactivity and pulmonary complications perioperatively. Chronic alcoholism leads to higher dose requirements for anesthetics, while narcotic abuse causes tolerance to opioids both during and after surgery.

3. Family History. Has anyone in the family had any unusual or adverse reactions under anesthesia? (Malignant hyperthermia, although rare, is a hereditary disease that can be rapidly fatal if unsuspected.)

Physical Examination

1. Airway. Specific findings may indicate a difficult airway, including poor mouth opening, poor cervical mobility, a short thyromental distance or receding chin, a large tongue or prominent incisors, and a short, muscular neck. The famous Mallampati classification helps predict difficult visualization during laryngoscopy.

2. Cardiovascular. Look for murmurs, arrhythmias, gallop rhythms, or a pericardial rub.

3. Pulmonary. Auscultate for wheezing, rales, or rhonchi. Check for tracheal deviation.

Giving anesthesia, or what is fondly called by other doctors as “passing gas,” has repeatedly been compared to flying a plane. Although I’ve never flown anything apart from a remote controlled toy chopper (which ended up in a pretty artistic pile at the end of my driveway), this metaphor works pretty well considering the similarities. The entire process involves multiple safety checks, intense moments during “takeoff and landing,” cruise control in the middle, and the fact that the chances for things going wrong is very, very slim—but when they do, they happen very quickly, and can end in catastrophe. Every anesthesiologist recognizes this, and thus safety and vigilance is emphasized throughout our course of training.

The preoperative evaluation is thus our pre-flight check and security screen. Before allowing anybody to even “board”, we take every opportunity to find out any early warning signs. Identifying potential risks is essential in choosing the correct plan for anesthesia.

Miller’s 6th edition includes a really useful table of medical problems that proves to be helpful in designing an appropriate plan of anesthesia administration.

History Point	Anesthesia Plans That May Require Extra Time
Airway perceived as difficult to intubate	Obtain fiberoptic equipment; obtain skilled help
Asthma	Optimize therapy; use bronchodilators; possible extubate during deep anesthesia
Diabetes, insulin-dependent	Discuss insulin mgmt with primary care doctor; monitor blood glucose intraoperatively; determine presence of autonomic neuropathy (aspiration risk, treat with metoclopramide)
Drug Abuse	Consider HIV testing; prescribe medications to avoid withdrawal symptoms perioperatively.
GERD or Hiatal Hernia	Administer H_2 blockers or oral antacids, use rapid-sequence induction of anesthesia; or use awake intubation techniques and obtain appropriate equipment
Heart disease: valve disease, risk of bacterial endocarditis	Arrange for antibiotic administration 1 h prior to surgery
Malignant hyperthermia history or family history	Obtain clean anesthesia machine, use appropriate technique and precautions; have agents to treat hyperthermia available
MAO inhibitors	Discontinue therapy preoperatively if patient is not suicidal; lan for perioperative pain therapy
Pacemaker or automatic implantable defibrillator	Evaluate cause of pacemaker implementation; obtain repolarizing equipment or magnet; use electrocautery with altered position; use bipolar electrocautery
Peripheral motor neuropathy	Avoid succinylcholine
Pregnancy or uncertain pregnancy status	Monitor fetal heart rate; use oral antacids; adjust induction of anesthesia; determine status of pregnancy
Pulmonary tuberculosis	Use disposable breathing circuit or clean equipment; ensure adequate treatment prior to surgery
Renal insufficiency	Monitor fluid status intraoperatively
Adapted from table in Miller’s Anesthesia: 6th ed, 2005; Churchill Livingstone, Table 25-3, which is modified from data from Gibby et al: How often does the preoperative interview change anesthetic management? [abstract]. Anesthesiology 77:A1134, 1992.	

After considering the patient's risk factors, physical exam, and diagnostic results, we assign a patient a physical status classification, based on the American Society of Anesthesiologists (ASA 1 to ASA 5). ASA 1 patients are generally healthy and have no medical problems, while ASA 4 patients are moribund and incapacitated. This overall score helps establish the amount of perioperative risk involved for that particular patient.

Monitors & Equipment

Just as the FAA sets guidelines for pilots to perform final checks on their controls, gauges, and communication equipment, we anesthesiologists have guidelines for checking our equipment before any cases are done. We begin each day by preparing our operating rooms with a thorough check.

The anesthesia machine, ventilator, monitors, and supply cart are all checked and setup. On the machine we check that the gas delivery system and the backup or failsafe systems are functional, and that the monitors and gauges are working. We check our supply cart for airway devices and equipment, emergency equipment, and the necessary drugs for the case. For monitors, we prepare a pulse oximeter, oxygen/gas analyzer, blood pressure cuff, and an EKG—all of which are required monitors by the ASA. More complicated cases will require more invasive monitors such as arterial or central lines.

Having done our checks on both the patient and the equipment, we are ready to place the patient under anesthesia. Cleared for take-off. To demonstrate a typical case, let's describe a general anesthesia case.

Induction of Anesthesia

In preparation for surgery, patients receive an intravenous line for rapid administration of anesthetics and other medications. Normal saline or Lactated Ringer's solution are typical solutions used intraoperatively. In some cases, it may be helpful to premedicate very anxious patients with midazolam (a very rapid acting benzodiazepine), or to treat patients with severe reflux disease or a full stomach with metoclopramide (a prokinetic agent) and an H2blocker like famotidine.

Once in the room, the patient is laid comfortably on the OR table and connected to all appropriate monitors. We give sedative doses of midazolam (anxiolytic and amnestic) and fentanyl (a rapid acting opioid with analgesic and sedative properties) to help the patient relax. Glycopyrrolate is often given as well to reduce oropharyngeal secretions (anticholinergic drug, thus having anti-vagal effects).

The induction begins with preoxygenating the patient with 100% oxygen. A facemask is gently placed on the patient while he is instructed to take 5 maximal inspiration breaths, with the goal of achieving 100% SpO2. This replaces all nitrogen in the lungs with pure oxygen, giving the patient a full reserve of oxygen in preparation for the period of apnea ahead.

A potent, short-acting hypnotic medication, also called an induction agent, is then injected to cause rapid loss of consciousness. Propofol, and etomidate are commonly chosen induction agents because of their quick onset of action—patients lose consciousness within 1 minute from IV administration. Gently brushing the eyelashes to check for lid movement quickly confirms unconsciousness.

At this point, patients often become apneic and we may have to assist ventilation by facemask. We verify that the patient can be mask ventilated by looking for chest rise and detecting CO2 on exhalation (via capnography). Assuming easy ventilation, we then administer a paralytic or neuromuscular blocking agent such as succinylcholine (a depolarizing muscle relaxant) or rocuronium (a nondepolarizing relaxant). We can check degree of paralysis with a twitch monitor, an device that elicits muscle twitches through measured bursts of electricity. Once adequate, we can then attempt to intubate. You may notice some anesthesiologists turn on an anesthetic gas while mask ventilating—this is because our induction agents are very short acting, and it is best to make sure our anesthetics haven't worn off by the time we intubate.

Now comes intubation. Holding the laryngoscope in the left hand, we open the patient's mouth with the right hand by using a scissoring motion on the teeth, or by tilting the patient's head slightly back. We insert the laryngoscope and advance the blade, sweeping the tongue to the left as we do so, until we see the epiglottis. Assuming we are using a Macintosh blade, we advance the tip of the blade further into the vallecula by lifting the laryngoscope upwards with the left upper arm (and NOT twisting the left wrist back which can cause the blade to damage the patient's upper teeth). If properly done, the blade should raise the vallecula, lifting the epiglottis with it, and revealing the vocal cords just beyond it. Keeping an eye on the glottis, we insert the endotracheal tube carefully between the cords until the deflated balloon is no longer visible. The laryngoscope is then gently removed, the tube held carefully in place, and the balloon is inflated while the circuit is connected to the tube. A few manual breaths are given to check for good placement—bilateral breath sounds, chest rise, and adequate end tidal CO_2 by capnography all signify correct placement. If confirmed, we tape the tube securely, switch the ventilator on, and give the patient a combination of O_2, air or nitrous oxide, and a volatile anesthetic gas.

Maintenance

Just as the actual flying is smoother (and otherwise boring) compared to take-off and landing, the maintenance period of anesthesia may seem easy. Keeping the patient anesthetized on a ventilator and anesthetic gas seems as close as it can get to "autopilot" since the patient remains in this state until the end of surgery. But in reality, several things need to be done during this time. A deeply anesthetized patient is utterly vulnerable to many physiologic insults. Vigilance is essential to maintain homeostasis (oxygenation, hemodynamics, acid-base balance, temperature, and volume status) and to regulate anesthetic depth. The homeostatic mechanisms necessary for life become the anesthesiologist's task.

Depth of anesthesia is constantly gauged by monitoring physiologic signs and responses to surgical stimulation. Somatic responses (movement, coughing, changes in respiratory pattern) or autonomic responses (tachycardia, hypertension) may suggest inadequate anesthetic depth, but the anesthesiologist also has to discern when hemodynamic changes are due to surgical manipulations (bleeding, caval compression, adrenal manipulation) rather than to depth of anesthesia.

Anesthesia is maintained by using potent, volatile agents (isoflurane, desflurane, sevoflurane), usually combined with short-acting intravenous agents (opioids) and nitrous oxide (rapid acting anesthetic gas with analgesic properties). Combining agents helps us avoid the potential problem of large doses of single anesthetic agents, such as toxicity.

It is during this time that a good anesthesiologist prepares a patient for the postoperative period. We can administer pain medications such as morphine (longer-acting opioid) and ketorolac (NSAID), and antiemetics such as metoclopramide and ondansetron.

Emergence

Continuing the analogy of flying, an untimely emergence can be as unpleasant (and possibly as disastrous) as a rough landing. Timing plays a large role in a good emergence and is mostly learned by experience. Anesthetics are gradually lowered towards the end of surgery until the patient is finally ready to be awakened. A patient has to be able to make the transition from an unconscious state to an awake state with intact protective reflexes.

Assuming we were aiming to perform an awake extubation, the patient must be fully awake and able to follow simple verbal commands. Hemodynamics should be stable, and the patient able to breathe spontaneously with adequate oxygenation and ventilation. Neuromuscular paralysis should have worn off or should be fully reversed in order to minimize the risk of airway obstruction or pulmonary aspiration on extubation.

If all criteria are met, the patient is extubated. IV lidocaine may be given to suppress bucking (or coughing against an ET tube). The patient is allowed to breathe 100% oxygen, and the oropharynx is suctioned. The ETT cuff is deflated, and the tube removed. 100% oxygen is administered by mask, and the patient observed closely until the patient's ventilation, oxygenation, and airway reflexes are confirmed adequate. He is then promptly transferred to the recovery room / Post-anesthesia Care Unit (PACU) for monitoring.

Recovery

Patients are monitored for postoperative pain, nausea and vomiting, hemodynamic stability, and recovery of mental status. Supplemental oxygen should be always available, and the patient's overall condition continually observed, as complications may suddenly become apparent during this period. Specific concerns such as upper airway obstruction, vomiting and aspiration, and change in mental status must all be detected and addressed quickly.

Summary

Your 2-week anesthesia rotation is designed to give you a glimpse into the inner workings of a specialty that deals closely with physiology and pharmacology on a daily basis. It is a field that will challenge your knowledge of both basic and applied sciences on an intensive one-on-one setting, and will enhance your understanding of the concerns of patients undergoing surgery. Don't hesitate to ask us questions as you keep learning more—whether practical or purely academic. It will also give you an opportunity to brush up on skills you may need in the future—IV access, facemask ventilation, and intubations. Enjoy this rotation, and you may look back at this as a fun experience that you learned a few helpful things from.

Appendix

Appendix !: Mallampati Airway Classification

Evaluating the oropharynx by asking the patient to open his mouth and stick out his tongue (but not vocalizing)

- **Class 1:** able to visualize the soft palate, fauces, uvula, tonsillar pillars
- **Class 2:** able to visualize the soft palate, fauces and uvula
- **Class 3:** only the soft palate and base of uvula are visible
- **Class 4:** only the soft palate can be seen (uvula obscured by tongue)

Appendix II: ASA Physical Status Classification

ASA -1: Normal healthy patient

ASA -2: Mild systemic disease (mild diabetes, controlled hypertension, obesity)

ASA -3: Severe systemic disease, some functional limitations (angina, COPD, prior myocardial infarction)

ASA -4: Severe systemic disease, incapacitating, and a constant threat to life

ASA -5: Moribund patient, not expected to survive 24 hours without surgery

ASA -6: Brain-dead patient undergoing organ harvest

E: Added when the case is emergent

Appendix III: Commonly Used Medications

Volatile Anesthetics

- **Halothane**

  Pro: Cheap, Nonirritating (can be used for inhalation induction)

  Con: Slower induction and recovery; significant myocardial depression, sensitizes myocardium to catecholamines, risk of halothane hepatitis
- **Isoflurane**

  Pro: Cheap, Excellent renal, coronary, and cerebral blood flow preservation

  Con: Slow induction and recovery, Irritating (not for inhalation induction)
- **Sevoflurane**

  Pro: Rapid induction and recovery; non-irritating, sweet odor (great for inhalation induction)

  Con: Expensive; produces toxic metabolite with CO_2 absorber, so higher fresh gas flows are recommended
- **Desflurane**

  Pro: Extremely rapid induction and recovery; pharmacodynamic effects very similar to isoflurane

  Con: Requires a special heated vaporizer; pungent and irritating; can stimulate sympathetic nervous system if increased rapidly
- **Nitrous Oxide**

  Pro: powerful analgesic, rapid induction and recovery; decreases the MAC and accelerates the uptake of other agents

  Con: Diffuses freely into gas filled spaces (bowel, pneumothorax, middle ear, gas bubbles used during retinal surgery), increases pulmonary vascular resistance; supports combustion and can contribute to fires; increases risk of postoperative nausea and vomiting; decreases myocardial contractility

Intravenous Anesthetics

All have very rapid onset (<1 minute) and short duration (5 -8 minutes)

- **Thiopental**
  - Pro: excellent brain protection, stops seizures, cheap
  - Con: induction causes a drop in blood pressure and tachycardia, venous irritation, contraindicated in porphyria
- **Propofol**
  - Pro: antiemetic, quick recovery if used as sole anesthetic agent
  - Con: pain on injection, expensive, supports bacterial growth, myocardial depression (the most of the four), hypotension more pronounced than with thiopental (drops SVR, contractility, and preload)
- **Etomidate**
  - Pro: Least myocardial effect of IV anesthetics
  - Con: pain on injection, adrenal suppression (? significance if used only for induction), myoclonus, nausea/vomiting
- **Ketamine**
  - Pro: Works IV, PO, PR, IM – good choice in uncooperative patient without IV access; stimulation of sympathetic NS, thus good for hypovolemic trauma patients; often preserves airway reflexes
  - Con: Dissociative anesthesia with postop dysphoria and hallucinations, Increases ICP/IOP and $CMRO_2$; stimulation of SNS, thus bad for patients with compromised cardiac function; increases airway secretions

Local Anesthetics

- **Esters** – Metabolized by plasma esterases – one metabolite is PABA, which can cause allergic reactions. Patients with "allergy to novacaine" usually do well with amides for this reason. All have only one "i" in their name, eg. Procaine, Tetracaine
- **Amides** – Metabolized by hepatic enzymes. All have at least two "i"s in their name, eg. Lidocaine, Bupivacaine

Opioids

- **Morphine** – long acting, histamine release; produces a renally excreted active metabolite with opiate properties, therefore beware in renal failure
- **Demerol** - euphoria, stimulates catecholamine release, so beware in patients using MAOI's, renally excreted active metabolite associated with seizure activity, renally excreted metabolite with seizure potential , thus beware in CRF
- **Fentanyl/Alfentanil/Sufentanil** – low doses produce brief effect, but larger doses are long acting, increased incidence of chest wall rigidity vs. other opiates, no active metabolites
- **Remifentanil** – almost instantaneous onset/offset of action due to metabolism by plasma esterases, must be given as continuous infusion, significant incidence of chest wall rigidity and nausea/vomiting

Muscle Relaxants

Depolarizing (Succinylcholine) · Succinylcholine mimics acetylcholine by depolarizing the postsynaptic membrane at the NMJ but prevents repolarization. It has a rapid onset of action (30-60 sec) with a short duration (5 to 10 min), and is rapidly metabolized in plasma. Associated with increased ICP/IOP, muscle fasciculations, and postop muscle aches; triggers MH; increases serum potassium, possibly to fatal levels in patients with burns, crush injury, spinal cord injury, or muscular dystrophy

Nondepolarizing Muscle Relaxants

· Many different kinds, all ending in "onium" or "urium". Each has different site of metabolism, onset, and duration making choice depend on specific patient and case. Some examples:

Pancuronium - Slow onset, long duration, tachycardia due to vagolytic effect.

Cisatracurium - Slow onset, intermediate duration, Hoffman (nonenzymatic) elimination so attractive choice in liver/renal disease.

Rocuronium - Fastest onset of nondepolarizers, thus making it useful for rapid induction, intermediate duration.

Reversal Agents are acetylcholinesterase inhibitors, thereby allowing more acetylcholine to be available to overcome the neuromuscular blocker effect at the nicotinic receptor, but also causing muscarinic stimulation

- **Neostigmine** – shares duration of action with glycopyrrolate (see below)
- **Edrophonium** – shares duration of action with atropine (see below)
- **Physostigmine** – crosses the BBB, therefore useful for atropine overdose

Anticholinergics are given with reversal agents to block the muscarinic effects of cholinergic stimulation, also excellent for treating bradycardia and excess secretions

- **Atropine** – used in conjunction with edrophonium, crosses the BBB causing drowsiness, so may be bad at end of surgery for reversal; some use as premed for all children since they tend to become bradycardic with intubation and produce copious drool
- **Glycopyrrolate** – used in conjunction with neostigmine, does not cross the BBB