A Medical Student's Anesthesia Primer

or

How to Look like a Star on Your First Day

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1. Introduction

At my medical school and in many programs across the country, medical students are only exposed to two weeks of anesthesiology during their third or fourth year. The student often attends daily lectures and might be told to "read Miller's *Basics of Anesthesia*", but often by the time the student has finally figured out why we are doing what we're doing, the rotation is over, and he or she leaves with only a minimum of anesthesia knowledge.

This primer is intended to give a brief overview of what we do, when we do it, and why we do it for standard, uncomplicated cases...the types that you are bound to see during your rotation. By no means is the information contained comprehensive, or intended to allow you to practice anesthesia solo, but it is intended to give an overview of the "big picture" in a format that can be quickly read in one sitting, then referred to as needed. Keep in mind that there are many ways to accomplish the same thing in anesthesia, and you will undoubtedly see techniques that differ from what I've written here, but my goal again is to present you with a simple overview. At the request of many of the students that have read this primer, I've now added a series of appendices for reference purposes.

Anesthesia is a challenging and exciting specialty, but can also be extremely frustrating if not taught clearly during the short exposure that many medical students get to the field.

Enjoy, and please email me your comments and critiques at **roysoto@ucla.edu**.

2. Preoperative History and Physical

Unlike the standard internal medicine H&P, ours is much more focused, with specific attention being paid to the airway and to organ systems at potential risk for anesthetic complications. The type of operation, and the type of anesthetic will also help to focus the evaluation.

Of particular interest in the history portion of the evaluation are:

Coronary Artery Disease -- What is the patient's exercise tolerance? How well will his or her heart sustain the stress of the operation and anesthetic. Asking a patient how he feels (ie. SOB, CP) after climbing two or three flights of stairs can be very useful as a "poor man's stress test".

Hypertension -- How well controlled is it? Intraoperative blood pressure management is affected by preoperative blood pressure control.

Asthma -- How well controlled is it? What triggers it? Many of the stressors of surgery as well as intubation and ventilation can stimulate bronchospasm. Is there any history of being hospitalized, intubated, or prescribed steroids for asthma? This can help assess the severity of disease.

Kidney or Liver disease -- Different anesthetic drugs have different modes of clearance and organ function can affect our choice of drugs.

Reflux Disease -- Present or not? Anesthetized and relaxed patients are prone to regurgitation and aspiration, particularly if a history of reflux is present.

Smoking -- Currently smoking? Airway and secretion management can become more difficult in smokers.

Alcohol Consumption or Drug Abuse? -- Drinkers have an increased tolerance to many sedative drugs (conversely they have a decreased requirement if drunk), and are at an increased risk of hepatic disease, which can impact the choice of anesthetic agents.

Diabetes -- Well controlled? The stress response to surgery and anesthesia can markedly increase blood glucose concentrations, especially in diabetics.

Medications -- Many medications interact with anesthetic agents, and some should be taken on the morning of surgery (blood pressure medications) while others should probably not (diuretics, diabetes medications).

Allergies -- We routinely give narcotics and antibiotics perioperatively, and it is important to know the types of reactions that a patient has had to medications in the past.

Family History -- There is a rare, but serious disorder known as malignant hyperthermia that affects susceptible patients under anesthesia, and is heritable.

Anesthesia history -- Has the patient ever had anesthesia and surgery before? Did anything go wrong?

Last Meal -- Whether the patient has an empty stomach or not impacts the choice of induction technique.

During the physical examination, particular attention is paid to the airway by asking the patient to "open your mouth as wide as you can and stick out your tongue" (but NOT by "saying ahhhh"). The classification scale of Mallampati is commonly used, and can be found in Appendix I. Also, any loose or missing teeth should be noted, as should cervical range of motion, mouth opening, and thyromental distance, all of which will impact the actual intubation prior to surgery.

Finally, a physical status classification is assigned, based on the criteria of the American Society of Anesthesiologists (ASA1-5), with ASA-1 being assigned to a healthy person without medical problems other than the current surgical concern, and ASA-5 being a moribund patient, not expected to survive for more then twenty-four hours without surgical intervention. An "E" is added if the case is emergent. The full details of the classification scale can be found in Appendix II.

3. IV's and Premedication

The two skills you should take the opportunity to practice while on your rotation are IV insertion and airway management/intubation. Every patient (with the exception of some children that can have their IV's inserted following inhalation induction) will require IV access prior to being brought to the operating room. The key to success with IV placement is preparation and patience. All of us have successfully found and cannulated a vein, only to find that we left the bag of IV fluid or the tape across the room. Normal saline, Lactated Ringer's solution, or other balanced electrolyte solutions (Plasmalyte, Isolyte) are all commonly used solutions intraoperatively.

Many patients are understandably nervous preoperatively, and we often premedicate them, usually with a rapid acting benzodiazepine such as intravenous midazolam (which is also fabulously effective in children orally or rectally). Metoclopramide and an H2 blocker are also often used if there is a concern that the patient has a full stomach, and anticholinergics such as glycopyrrolate can be used to decrease secretions.

4. Room Setup and Monitors

Before bringing the patient to the room, the anesthesia machine, ventilator, monitors, and cart must be checked and set up. The anesthesia machine must be tested to ensure that the gauges and monitors are functioning properly, that there are no leaks in the gas delivery system, and that the backup systems and fail-safes are functioning properly. The details are beyond the scope of a two week rotation, but you should know that we all do this routinely each morning when we enter our rooms.

The monitors that we use on most patients include the pulse oximeter, blood pressure monitor, and electrocardiogram, all of which are ASA requirements for patient safety. Each are checked and prepared to allow for easy placement when the patient enters the room. You may see some more complicated cases that require more invasive monitoring such as arterial or central lines.

The anesthesia cart is set up to allow easy access to intubation equipment including endotracheal tubes, laryngoscopes, stylets, oral/nasal airways and the myriad of drugs that we use daily. A properly functioning suction system is also vital during any type of anesthetic.

Other preparations that can be done before the case focus on patient positioning and comfort, since anesthesiologists ultimately are responsible for intraoperative positioning and resultant neurologic or skin injuries. Heel and ulnar protectors should be available, as should axillary rolls and other pads depending on the position of the patient.

5. Induction and Intubation

You now have your sedated patient in the room with his IV (gender selected at random…you generally anesthetize men and women the same), and he's comfortably lying on the operating table with all of the aforementioned monitors in place and functioning. It is now time to stow your tray tables and bring your seats to the full upright position, because it's time for take-off. Indeed, many people compare anesthesia with flying an aircraft since the take-off and landing can be quite rocky at times whereas the actual flying can seem like smooth sailing.

The first part of induction of anesthesia should be preoxygenation with 100% oxygen delivered via a facemask. The goal should be an end-tidal oxygen concentration of more than 80%, a SaO2 of 100%, or lacking end tidal gas monitoring, at least four full tidal volume breaths with a tight fitting mask. Again, using the example of a normal smooth induction in a healthy patient with an empty stomach, the next step is to administer an IV anesthetic until the patient is unconscious. A useful guide to anesthetic induction is the loss of the lash reflex, which can be elicited by gently brushing the eyelashes and looking for eyelid motion. Patients frequently become apneic after induction and you may have to assist ventilation. The most common choices used for IV induction, probably in order of frequency, are Propofol, Thiopental, Etomidate, and Ketamine. (See Appendix III for details)

Assuming that you are now able to mask ventilate the patient, the next step is usually to administer a neuromuscular blocking agent such as succinylcholine (a depolarizing relaxer) or vecuronium (or any of the other -oniums or -uriums, which are all nondepolarizing relaxers). A twitch monitor is usually used to ascertain depth of relaxation, and when the twitch has sufficiently diminished, intubation can be attempted. Note that the above induction agents usually last for less than ten minutes, so many of us will turn on a volatile anesthetic agent while we are mask ventilating and waiting for the muscle relaxant to take effect. Try to keep a good mask seal so you don't anesthetize yourself…

Once the patient is adequately anesthetized and relaxed, it's time to intubate, assuming you have all necessary supplies at the ready. Hold the laryngoscope in your left hand (whether you're right or left handed) then open the patient's mouth with your right hand, either with a head tilt, using your fingers in a scissors motion, or both. Insert the laryngoscope carefully and advance it until you can see the epiglottis, sweeping the tongue to the left. Advance the laryngoscope further into the vallecula (assuming you're using a curved Macintosh blade), then using your upper arm and NOT your wrist, lift the laryngoscope toward the juncture of the opposite wall and ceiling. There should be no rotational movement with your wrist, as this can cause dental damage. When properly done, the blade should never contact the upper teeth. Once you see the vocal cords, insert the endotracheal tube until the balloon is no longer visible, then remove the laryngoscope, hold the tube tightly, remove the stylet, inflate the cuff balloon, attach the tube to your circuit and listen for bilateral breath. If you have chest rise with ventilation, misting of the endotracheal tube, bilateral breath sounds and end tidal CO2, you're in the right place and all is well! Tape the tube securely in place, place the patient on the ventilator, and set your gas flows appropriately.

6. Maintenance

As with flying an airplane, the maintenance portion of anesthesia can be very smooth, but when things go wrong, they can go very wrong very quickly. Therefore it is vital to continually monitor vital signs, end-

tidal oxygen, CO_2, N_2O, and volatile agent levels, presence or absence of twitch, and patient position, as positioning changes can occur with table movement/tilt (or surgeon input).

It is also vital to pay attention to the case itself, since blood loss can occur very rapidly, and certain parts of the procedure can threaten the patient's airway, especially during oral surgery or ENT cases. It is also important to keep track of the progress of the case. It is a common beginner's mistake to give patients a muscle relaxant that lasts for an hour when the case only has 10 minutes to go. A good anesthesiologist has a "sixth sense." He or she is always paying attention to the tone of the pulse oximeter or the slurping of blood into the suction canister. Vigilance is key to a good anesthetic.

One can also prepare for potential post-operative problems during the case, by treating the patient intraoperatively with long-acting anti-emetics and pain medications.

7. Emergence

Using our analogy of flying an airplane, a poor landing/emergence can be disastrous. Knowing when to turn down/off your anesthetic agents comes with experience and attention to the progress of the surgical case. Emergence isn't as easy as it might at first seem, since very important steps have to take place before a patient can be safely extubated.

First, the patient's neuromuscular blockade must be re-assessed, and if necessary reversed and then rechecked with a twitch monitor. Next, the patient has to be able to breathe on his own, and ideally follow commands, demonstrating purposeful movement and the ability to protect his airway following extubation. Suction must always be close at hand, since many patients can become nauseous after extubation, or simply have copious oropharyngeal secretions. Once the patient is reversed, awake, suctioned, and extubated, care must be taken in transferring him to the gurney and oxygen must be readily available for transportation to the recovery room/Post-Anesthesia Care Unit (PACU). Finally, remember that whenever extubating a patient, you must be fully prepared to reintubate if necessary, which means having drugs and equipment handy.

8. PACU Concerns

The anesthesiologist's job isn't over once the patient leaves the operating room. Concerns that are directly the responsibility of the anesthesiologist in the immediate postoperative period include nausea/vomiting, hemodynamic stability, and pain.

Other concerns include continuing awareness of the patient's airway and level of consciousness, as well as follow-up of intraoperative procedures such as central line placement and postoperative X-rays to rule out pneumothorax. A resident and staff member are usually assigned to the PACU specifically to follow up on these concerns, since we frequently have to return to the OR for subsequent cases, and may not be available if problems should arise.

In summary, anesthesia is a specialty in which an extensive knowledge of physiology and pharmacology can be applied to the care of patients in a unique one-on-one intensive care setting. Challenge your residents and attendings to teach you what you don't understand, and get as much practice with IV's and intubations as possible. Also, remember that at the heart of anesthesiology are the ABC's – airway, breathing and circulation. No matter what field you may enter, basic knowledge of the ABCs is part of any complete physician's repertoire. Enjoy!

Appendix I: Mallampati Classification

Evaluation of the oropharynx is accomplished by asking the patient to open his mouth and stick out his tongue (but not by vocalizing).

Class I:	Entire uvula and tonsillar pillars visible
Class II:	Tip of uvula and pillars hidden by tongue
Class III:	Only soft palate visible
Class IV:	Only hard palate visible

Appendix II: ASA Physical Status Classification

ASA-I:	Healthy patient with no systemic disease
ASA-II:	Mild systemic disease , no functional limitations
ASA-III:	Moderate to severe systemic disease, some functional limitations
ASA-IV:	Severe systemic disease, incapacitating, and a constant threat to life
ASA-V:	Moribund patient, not expected to survive > 24 hours without surgery
ASA-VI:	Brain-dead patient undergoing organ harvest
E:	Added when the case is emergent

Appendix III: Commonly Used Medications

- Volatile Anesthetics
  - Halothane
    - Pro: Cheap, Nonirritating so can be used for inhalation induction
    - Con: Long time to onset/offset, Significant Myocardial Depression, Sensitizes myocardium to catecholamines, Association with Hepatitis
  - Isoflurane
    - Pro: Cheap, Excellent renal, hepatic, coronary, and cerebral blood flow preservation
    - Con: Long time to onset/offset, Irritating so cannot be used for inhalation induction
  - Sevoflurane
    - Pro: Nonirritating so can be used for inhalation induction, Extremely rapid onset/offset
    - Con: Expensive, Due to risk of "Compound A" exposure must be used at flows >2 liters/minute, Theoretical potential for renal toxicity from inorganic fluoride metabolites
  - Desflurane
    - Pro: Extremely rapid onset/offset
    - Con: Expensive, Stimulates catecholamine release, Possibly increases postoperative nausea and vomiting, Requires special active-temperature controlled vaporizer due to high vapor pressure, Irritating so cannot be used for inhalation induction
- Nitrous Oxide
  - Pro: Decreases volatile anesthetic requirement, Dirt cheap, Less myocardial depression than volatile agents
  - Con: Diffuses freely into gas filled spaces (bowel, pneumothorax, middle ear, gas bubbles used during retinal surgery), Decreases FiO2, Increases pulmonary vascular resistance, Combustible like oxygen
- IV Anesthetics – All have very rapid onset (<1 minute) and short duration (5-8 minutes)
  - Thiopental
    - Pro: Excellent brain protection, Stops seizures, Cheap
    - Con: Myocardial depression, Vasodilation, Histamine release, Can precipitate porphyria in susceptible patients
  - Propofol
    - Pro: Prevents nausea/vomiting, Quick recovery if used as solo anesthetic agent
    - Con: Pain on injection, Expensive, Supports bacterial growth, Myocardial depression (the most of the four), Vasodilation
  - 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, Stimulation of SNS → good for hypovolemic trauma patients, often preserves airway reflexes
        - Con: Dissociative anesthesia with postop dysphoria and hallucinations, Increases ICP/IOP and CMRO2, Stimulation of SNS → 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, renally excreted active metabolite with opiate properties therefore beware in renal failure
    - Dilaudid – long acting, no active metabolites or histamine release, same onset/duration as morphine
    - 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 therefore beware in renal failure
    - 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 inhibits the postjunctional receptor and passively diffuses off the membrane, while circulating drug is metabolized by plasma esterases. Associated with increased ICP/IOP, muscle fasciculations and postop muscle aches, triggers MH, increases serum potassium especially in patients with burns, crush injury, spinal cord injury, muscular dystrophy or disuse syndromes. Rapid and short acting.
    - Nondepolarizing
        - 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 making it useful for rapid sequence induction, intermediate duration.
- Reversal Agents/Anticholinergics
    - Reversal Agents: all 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: 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 maybe 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