

Anesthesiology Advanced Clinical Rotation Handbook

Course 605A - Operating Room



UC Irvine Health™

Anesthesiology & Perioperative Care

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GENERAL INFORMATION

WELCOME

We are pleased to have you rotating with us. We hope you find the department to be a friendly group and eager to teach and get you involved. Our goal is for you to learn basic anesthesia principles, learn and practice hands on skills and learn about our department.

During the rotation you will work daily with a resident and attending to provide pre-operative, intraoperative, and post-operative care to a variety of patients from healthy outpatients to the critically ill. You will also spend time in some of our subspecialties, such as obstetrics and pain, to experience the scope of anesthesiology practice.

In addition to patient care, you will have the opportunity to attend our grand rounds, resident lectures and our case conference series directly geared for medical students.

We hope you enjoy your rotation with us. We encourage you to get involved, collaborate with your residents in the care of your patients, and take advantage of the opportunity to learn about this exciting field of medicine.

Sincerely,



Kyle Paredes, MD, MBA
Medical Student Clerkship Rotations Director

GOALS AND OBJECTIVES

PERIOPERATIVE MANAGEMENT

Preoperative Evaluation of the Surgical Patient

- The student should be able to perform a thorough history and physical. The student should recognize patient comorbidities and how they relate to the anesthetic care of the patient. The student should be aware of indications for further patient testing or need for further optimization prior to surgery.
- The student should be able to perform a thorough airway exam.
- The student should be aware of anesthetic options and will be able to formulate a basic anesthetic care plan.

Intraoperative Management

- The student should be able to perform a setup for a basic general anesthetic. Students should be aware of the basic functions of an anesthesia machine. Students should be able to apply basic ASA monitors and have an understanding of the function of each.
- The student should be aware of airway management options. Students should have a basic knowledge of the pharmacology of induction agents and their indications during an anesthetic induction. Students should be aware of the indications for a rapid sequence induction.
- The student should be able to recognize and evaluate intraoperative events such as hypotension, hypertension, hypoxia, and oliguria, as well as have a basic understanding of their management.
- The student should be able to recognize when a patient has met extubation criteria.

Postoperative Management

- The student should be aware of monitoring requirements in the post-anesthesia recovery unit (PACU). They should have an understanding of basic post-operative analgesia options.
- The student should be able to evaluate basic PACU events such as nausea, pain, hypotension, hypertension, and hypoxia.
- The student should be able to recognize when a patient has met criteria for PACU discharge.

PERIOPERATIVE CONSULTANT

The student should have an understanding of the role of anesthesiologists as a perioperative consultant.

- Acute pain management
- Labor analgesia
- Preoperative evaluation and optimization

LIFE SUPPORT SKILLS

Airway Management of the Unconscious Patient

- The student should be able to recognize apnea, hypoventilation, airway obstruction, and hypoxia.
- The student should be able to perform basic non-invasive airway maneuvers to open airway and restore ventilation such as the use of oral and nasopharyngeal airways and bag-mask. Students will be able to evaluate the efficacy of airway assistance maneuvers. The student will understand the basic principles of intubation and be able to confirm endotracheal tube placement.
- The student should understand the basics of the difficult airway algorithm.

Circulatory Support of the Hypotensive Patient

- The student should be able to recognize circulatory shock using observation, physical exam, and clinical monitors.
- The students should be able to place intravenous peripheral catheters. The student will have a basic understanding of the pharmacology of commonly used drugs for the control of heart rate, vascular tone, rhythm, and myocardial contractility. Student will understand the role of crystalloid/colloid in the hypotensive patient.

Basic Life Support Skills

- The student should understand the basics of CPR and demonstrate BLS proficiency.

METHODS

CLINICAL

Students will participate daily as a member of the anesthesia care team and are expected to participate in all anesthetic and related activities their resident is involved in during the day.

- Students will be assigned to work with a specific resident for the first part of the rotation.
- Progressive involvement of the clinic management of patients will be fostered under the direction of the resident and attending faculty.
- Students will spend the second part of the rotation rotating with the specialty services.

Activities include:

- Assisting in OR setup for the surgical cases.
- Assisting with the preoperative evaluation of their patients.
- Assisting with intraoperative management of the patient.
- Rounding with the acute pain service and assisting in management of post-operative pain issues on the floor.
- Rounding with the OB team and assisting with providing labor analgesia and anesthesia for cesarean section.

DIDACTIC

Attendance is required at grand rounds and clinical base year and CA-1 lectures. A weekly clinical case conference series is also provided specifically for medical students.

Organized discussions with residents on the listed anesthesia topics in the OR and completion of the checklist will provide supplemental teaching outside lecture time.

GRADING POLICY & EVALUATIONS

GRADING POLICY

The grading system is Honors/Pass/Fail.

Final grades will be based on the following:

- Evaluations by residents and attendings in the OR
- Attendance and participation in the lectures, grand rounds, and clinical case conferences
- Completion of topic discussion checklist
- Post-test score

(The pre-test serves merely to gauge the knowledge base of our incoming medical students with regards to anesthesia and is not included in your rotation grade. You must score at least 80% on the post-test to be considered for honors.)

EVALUATIONS

It is your responsibility to ask the residents and attendings you work with to fill out an evaluation for you. Please get a confirmation from the resident or attending that he/she is willing to fill out an evaluation. Notify the course co-ordinator who the attendings and residents will be that have agreed to evaluate you.

Please note that students for which we have no evaluations will be at risk for failing the course.

You will also be evaluating the residents and attendings with whom you worked, as well as the course rotation.

Attending and resident evaluations of your performance will be factored in based on the following guidelines:

- **Knowledge:** The student demonstrated appropriate knowledge of medicine and surgery for his/her educational level and was able to apply that knowledge clinically.
- **Clinical Skills:** The student was able to learn and perform hands-on techniques (IV cannulation, mask ventilation, and airway management).
- **Patient Care:** The student interacted well with his/her patients, performed interviews well, and conveyed information to the team appropriately.
- **Motivation:** The student demonstrated a desire to learn and participate.
- **Teachability:** The student demonstrated an ability to listen and assimilate new information and apply that information to the situation at hand.
- **Professionalism:** The student was professional in his/her interactions with patients, residents, staff, and attendings.
- **Self-Analysis:** The student has an awareness of his/her own limitations in knowledge and skills and makes efforts to improve on them.
- **Desirability:** This medical student would make a good resident and we should seek to recruit him/her to our program.
- **Comments**

WEEKLY SCHEDULE

MONDAY	6:30 a.m. – 6:45 a.m.	Operating Room Setup
	6:45 a.m. – 7:15 a.m.	Preoperative Evaluation
	7:15 a.m. – 3:00 p.m.	Operating Room
TUESDAY*	6:30 a.m. – 6:45 a.m.	Operating Room Setup
	6:45 a.m. – 7:15 a.m.	Preoperative Evaluation
	7:15 a.m. – 3:00 p.m.	Operating Room
	10:30 a.m. – 11:30 p.m.	Medical Student Case Conference
WEDNESDAY*	6:30 a.m. – 6:45 a.m.	Operating Room Setup
	6:45 a.m. – 7:15 a.m.	Preoperative Evaluation
	7:15 a.m. – 3:00 p.m.	Operating Room
THURSDAY	6:30 a.m. – 7:30 a.m.	Grand Rounds
	7:45 a.m. – 8:15 a.m.	Peroperative Evaluation
	8:15 a.m. – 3:00 p.m.	Operating Room
FRIDAY	6:30 a.m. – 6:45 a.m.	Operating Room Setup
	6:45 a.m. – 7:15 a.m.	Preoperative Evaluation
	7:15 a.m. – 3:00 p.m.	Operating Room

* See Weekly Bulletin for clinical base year and CA-1 Didactic lecture schedules.

CURRICULUM

BASIC & ESSENTIAL ANESTHESIA PHARMACOLOGIC AGENTS

Albuterol
Ipratropium

Atropine
Dobutamine
Dopamine
Ephedrine
Epinephrine
Glycopyrolate
Neostigmine
Nitroglycerine
Nitroprusside
Norepinephrine
Phenylephrine

Alfentanil
Fentanyl
Hydromorphone
Meperidine
Morphine
Remifentanyl
Sufentanil
Ketorlac

Atracurium
Cisatracurium
Rocuronium
Vecuronium
Mivcurium
Pancuronium
Succinylcholine

Sevoflurane
Isoflurane
Desflurane
Nitrous Oxide

Bupivacaine
Lidocaine
Ropivacaine

Etomidate
Ketamine
Lorazepam
Midazolam
Propofol
Thiopental

Droperidol
Metocloperamide
Ondansetron
Scopolamine

Flumazenil
Naloxone

Albumin
Lactated Ringers
Normal Saline
Hespan
Sodium Bicarbonate

Esmolol
Hydralazine
Labetalol
Metoprolol

Protamine

Dexamethasone
Hydrocortisone

Dexmedetomidine

Mannitol
Furosemide

Dantrolene

Chapter 6: Clinical Cardiac and Pulmonary Physiology

1. What are the physiological components of mean arterial pressure (MAP)?
2. How is blood pressure measured in the OR? Discuss the pros and cons of the different techniques.
3. What is the differential diagnosis for tachycardia under general anesthesia?
4. How do both tachycardia and bradycardia cause a low cardiac output?
5. Discuss the functions of the carotid sinus baroreceptor.
6. Discuss the unique features of the coronary circulation. Why is the left ventricle mainly perfused during diastole? What effect does tachycardia have on left ventricle perfusion?
7. Describe hypoxic pulmonary vasoconstriction.
8. What are the west zones of the lung?
9. What events shift the oxyhemoglobin dissociation curve to the right? What does a right shift mean in physiological terms?
10. What is anatomic and alveolar dead space?
11. Describe the hypercapnic ventilatory response. How do opioids affect this response?
12. Discuss the hypoxic ventilatory response.

Notes:

Chapter 8: Inhaled Anesthetics

1. In relation to volatile anesthetics what does MAC mean? How is it useful?
2. Discuss the factors which increase and decrease MAC.
3. Discuss the factors which influence transfer of inhaled anesthetic from machine to lungs (alveoli).
4. Explain what a blood-gas partition coefficient of 1.5 means. Does a lower blood-gas partition coefficient slow down, or speed-up the rate of induction?
5. How does cardiac output affect the rate of induction?
6. What is the second gas effect?
7. What is diffusion hypoxia?
8. Why is N₂O use avoided in the presence of a closed pneumothorax?
9. Discuss the effects of inhaled anesthetics on mean arterial pressure, cardiac output, and SVR.
10. How do they affect heart rate and dysrhythmogenicity?
11. What are the effects of inhaled anesthetics on ventilation? What happens to the ventilatory response to CO₂ and O₂?
12. What are the effects of inhaled anesthetics on cerebral blood flow and CMRO₂?
13. How do they affect ICP?
14. How is hepatic injury following anesthesia classified?
15. What is malignant hyperthermia, how does it present, how is it managed?

Notes:

Chapter 9: Intravenous Anesthetics

1. Discuss the pharmacokinetics of propofol?
2. What are its effects in the different organ systems?
3. How is it used clinically?
4. How are barbiturates metabolized?
5. What are their effects on the cardiovascular system?
6. What properties of barbiturates make them useful in neuro-anesthesia?
7. What is the mechanism of action of benzodiazepines?
8. What are the effects of benzodiazepines on the respiratory system and the central nervous system?
9. What are the clinical uses of benzodiazepine?
10. What class of drugs does ketamine belong to?
11. What is the mechanism of action of ketamine?
12. What are its effects on the various organ systems?
13. What are the effects of etomidate on the cardiovascular system?
14. What class of drugs does dexmedetomidine belong to?
15. How does it exert its effects?
16. What are the effects on the cardiovascular and respiratory system?
17. How is it used clinically?

Clinical Application

In the following clinical scenarios, what IV anesthetics would you like to use and why?

- 70 y/o male with well controlled hypertension and CAD, presenting for elective colonectomy
- 25 y/o male, mentally challenged, agitated, no IV access for dental rehab
- 42 y/o previously healthy male in burn unit for lower extremity dressing change
- 30 y/o multigravid female for emergency C-section 2° to bleeding placenta previa, BP 80/40
- 27 y/o intoxicated male in ER, s/p MVA, combative, unable to obtain vital signs because of agitation

Notes:

Chapter 10: Opioids

1. What is the mechanism of action of opioids?
2. What are the different types of opioid receptors and the effects at these receptors?
3. Where are the receptors located?
4. How do neuraxial opioids exert their effect?
5. What are the advantages of neuraxial opioids vs. intravenous opioids?
6. What are the side effects of neuraxial opioids?
7. List the commonly used opioid agonists and their relative potencies.
8. Describe the pharmacokinetics of morphine.
9. What are the side effects of morphine?
10. How are the pharmacokinetics of fentanyl different from morphine?
11. Compare the side effects of fentanyl to those of morphine.
12. Describe the unique pharmacokinetics of remifentanyl.
13. Which opioid antagonist is most commonly used and how is it dosed?

Notes:

Chapter 11: Local Anesthetics

1. 50 y/o, 70 kg woman is having a bunionectomy under ankle block to be performed by the surgeon. He plans to use 0.5 % bupivacaine with epinephrine 1:200, 000.
 - What is the concentration of bupivacaine being used in mg/ml?
 - Why is epinephrine added to local anesthetic solutions?
 - Is the above solution appropriate for use in a penile block? Explain.
 - What is the maximum dose of bupivacaine for this patient in mg and ml?
 - Is bupivacaine an ester or amide? Name the esters and amides.
 - How are ropivacaine and levobupivacaine different from bupivacaine?
2. 3 minutes after injecting 20 ml of local anesthetic the surgeon tests the operative site and patient flinches.
 - What determines the speed of onset of local anesthetics?
 - What determines potency and duration?
 - Describe the onset and duration of common local anesthetics.
3. The surgeon decides to use some 2% lidocaine. Shortly afterward, patient reports feeling ill.
 - What are the signs and symptoms of local anesthetic toxicity?
 - How is lidocaine different from bupivacaine with respect to toxicity?
 - How common is an allergic reaction to local anesthetics?
 - Explain why local anesthetics are ineffective at the site of infection.

Notes:

Chapter 12: Neuromuscular Blocking Drugs

1. Classify neuromuscular blockers.
2. What is the choice of NMBD influenced by?
3. Describe the action of a NMBD at the neuromuscular junction.
4. What is the intubating dose of succinylcholine?
5. How is succinylcholine metabolized?
6. Describe the difference between Phase 1 and Phase 2 block.
7. What is the Dibucaine number? Describe its use.
8. What are the side effects of succinylcholine? How can these be reduced?
9. Which NMBD's have an effect on the cardiovascular system. How are these effects exerted?
10. Which NMBD's are eliminated primarily through the kidneys, and which through the liver?
11. How is neuromuscular blockade monitored?
12. How does train of four differ with depolarizing and non-depolarizing drugs? Phase 1 block and Phase 2?
13. How are NMBD's antagonized? Describe the typical combination of drugs used and the rationale for the use.
14. What factors determine the success of antagonism?
15. How is the adequacy of recovery from NMBD's evaluated?
16. What are the considerations if a patient remains weak after NMBD's is reversed?
17. Discuss the relationship of NMBD's to anaphylactic reactions under anesthesia.
18. What is sugammadex?

Notes:

Chapter 13: Preoperative Evaluation and Medication

1. What are the goals of a preoperative evaluation?
2. Why are patients questioned about sleep apnea?
3. What are some of the common risks and side effects of anesthesia which could be discussed with patients pre-op?
4. What are the specific areas targeted in the pre-op physical exam?
5. Discuss the ASA physical status classification.
6. What are the clinical predictors of cardiac risk?
7. Discuss the risk factors for post-op pulmonary complications.
8. How does duration of smoking cessation affect post-op risk of pulmonary complications?
9. How is thromboembolic risk stratified? What measures are used for prevention of DVT?
10. What are some patient risk factors for pulmonary aspiration?
11. Discuss the medications which could be helpful reducing the risk of pulmonary aspiration.
12. Review the NPO guidelines for elective surgery.
13. Discuss the general OR set for delivering an anesthetic including drugs, monitors, and equipment.

Notes:

Chapter 14: Choice of Anesthetic Technique

1. What are the choices of anesthetic technique available?
2. How is general anesthetic initiated?
3. Describe the events involved in rapid sequence induction.
4. When is this technique used?
5. What are the objectives during maintenance of general anesthesia?
6. Why is N₂O administered in combination with volatile anesthetics?
7. Neuraxial anesthesia is selected primarily for what surgical sites?
8. Why is a double tourniquet used in performing IVRA?
9. What are some of the advantages of peripheral nerve block?
10. Define MAC.
11. For the following clinical scenarios discuss your choice of anesthetic technique and the rationale for that choice:
 - 63 y/o male for cataract extraction
 - 28 y/o female for left breast lumpectomy
 - 27 y/o female for left breast mastectomy
 - 80 y/o male for colonoscopy
 - 73 y/o male for radical prostatectomy
 - 70 y/o female for emergency laparotomy for bowel obstruction
 - 12 y/o female for scoliosis repair
 - 50 y/o male for right knee ACL repair
 - 45 y/o diabetic in renal failure for hemodialysis access left arm
 - 63 y/o male for left inguinal hernia repair
 - 26 y/o female for Achilles tendon repair. She has a class 4 airway, obese, and will be in prone position.

Notes:

Chapter 16: Airway Management

1. Describe some factors elicited in patient history that are relevant to airway management.
2. What are the components of the airway examination?
3. What is the mallampati classification?
4. Can you predict difficult mask ventilation? How would you deal with this problem?
5. What are the indications for endotracheal intubation?
6. Describe the basic equipment needed for endotracheal intubation.
7. How do you confirm tracheal placement of ETT?
8. What are the complications of laryngoscopy and endotracheal intubation?
9. What are some of the alternatives to laryngoscopy and oral intubation?
10. Describe some instances where use of an LMA would be contraindicated.
11. What are the airway differences between children and adults?
12. What is laryngospasm and how is it treated?
13. What is stridor and how is it treated?

Notes:

Chapter 17: Spinal and Epidural Anesthesia

1. Compare and contrast spinal and epidural anesthesia.
2. Describe some surface landmarks used to identify spinal interspaces.
3. What interspaces are typically used for spinal anesthesia? Why?
4. What are the contraindications to neuraxial anesthesia?
5. Describe the approaches used for spinal anesthesia.
6. How does the Sprotte needle differ from the Quincke needle?
7. How do baricity and patient position affect local anesthetic distribution in the CSF?
8. What determines the duration of spinal blockade?
9. How is the epidural space identified?
10. What are the side effects and complications of epidural anesthesia?
11. How is a combined spinal-epidural performed?
12. Why is it used for knee replacement surgery or C-sections?

Clinical Applications

Twenty-eight y/o healthy female present for C-section BP 120/80, P115; she consents to spinal anesthesia and the surgery is expected to take less than an hour.

- What are the advantages and disadvantages of using lidocaine for this case?
- What dermatomes are represented at the umbilicus, xiphoid process and nipple?
- What sensory level is necessary to perform a C-Section?

About 10 minutes into the procedure the patient c/o nausea. Her BP is now 80/40, P 62.

- What are the mechanisms of hypotension associated with spinal blockade?
- Can it be prevented? How is it treated?
- What are the signs and symptoms of a high spinal? How is it treated?

In the PAR, the patient c/o headache.

- What are the classical features of a post-dural puncture headache?
- What are the risk factors?
- What are the treatment options?

Notes:

Chapter 19: Positioning and Associated Risks

1. Discuss the proper positioning of the upper extremities in the supine position.
2. What are the complications associated with supine position?
3. What are the cardiopulmonary effects of Trendelenburg?
4. Discuss the complications of lithotomy position.
5. How does the lateral decubitus position influence ventilation and perfusion of the non-dependent lung?
6. In the prone position what is the purpose of the bilateral chest rolls?
7. Describe the symptoms and signs of corneal abrasion. How can it be prevented and treated?

Clinical Application

A 42 y/o male presents for posterior for a craniotomy and surgeon wishes placement in sitting position.

- What are the advantages of the sitting position?

Immediately after induction and positioned sitting the patient is noted to be hypotensive.

- What causes the hypotension and how can it be treated?
- What monitors could be used to detect venous air embolism?
- Why is VAE a risk in the sitting position and how does it manifest?

The patient undergoes a successful operation, but complains two days later complains of numbness and weakness in his left hand.

- How would you differentiate clinically between radial, ulnar, and median nerve injury?
- What are some of the precautions taken to minimize risk of peripheral nerve injury?

Notes:

Chapter 20: Anesthetic Monitoring

1. What are the aims of anesthetic monitoring?
2. What monitors should be available to ensure adequate patient oxygenation during anesthesia?
3. How is adequate patient ventilation monitored according to ASA standard?
4. In EKG monitoring why is the 5 lead system used in adults vs. the 3 lead system in children?
5. What is the effect on the BP reading of placing a too small cuff on a patient?
6. When would you consider direct arterial pressure monitoring instead of a non-invasive method???
7. What are the complications of arterial cannulation?
8. How does pulseoximetry work?
9. Give examples of the factors which affect the accuracy of pulse oximetry.
10. What are the clinical uses of capnography?
11. Why do we monitor patient temperature?
12. What are the mechanisms for development of hypothermia in the anesthetized patient?
13. What are the advantages and uses for the BIS monitor?

Clinical Case

68 y/o male with history of hypertension, diabetes, CAD with left bundle branch block and good functional capacity presents for intracranial aneurysm clipping.

- Is arterial line indicated? Why/why not?
- Is PA catheter indicated? Why/why not?
- If you place a PA catheter, any particular concerns for the patient?

Notes:

Chapter 23: Fluid Management and Blood Transfusion

1. Give reasons for establishing central venous access.
2. Describe some causes of pre-op hypovolemia.
3. How is intravascular fluid volume evaluated?
4. Calculate the maintenance fluid requirements for a 70 kg man.
5. This man has had a bowel prep and then been NPO for 8 hrs. How do these affect intraoperative fluid maintenance requirements?
6. Would 0.5 N/S be appropriate for his fluid replacement? Explain.
7. During colon resection patient has had 300 ml EBL. What are the options for replacement of intravascular volume?
8. What complications are associated with the use of colloids?
9. What are the indications for blood transfusion?
10. How does a type and screen differ from a type & X-match? Give examples of surgery where each is appropriate.
11. What are the indications for FFP transfusion?

Notes:

Chapter 39: PACU & Acute Postoperative Pain Management

1. What are the adverse physiologic effects and clinical consequences of postoperative pain?
2. What is nociception?
3. What does peripheral modulation of nociception mean?
4. How do endorphins and enkephalins act to modulate nociception?
5. Describe the routes of delivery for analgesic drugs with example.
6. What are the advantages of IV PCA over intermittent IV or IM administration?
7. When generating a patient's PCA order set, what does the lockout interval mean?
8. Of neuraxial fentanyl and morphine, which opioid is more likely to cause delayed depression of ventilation? Why?
9. How is ventilatory depression from neuraxial opioids monitored?
10. How does DVT prophylaxis with SQ heparin affect the placement and removal of an epidural catheter for post-op analgesia?
11. What are the signs and symptoms of an epidural hematoma? How is this diagnosis confirmed and treated?
12. Describe the use of the VAS.

Clinical Application

60 y/o, 90 kg man is in the PACU recovering from an open cholecystectomy. He has a history of hypertension and MI. He is in a great deal of pain, especially with deep breathing.

- How can you quantify his pain?
- What complications could occur if this patient's pain is poorly controlled?

Initial pain orders are for morphine 10 mg IM q4h prn pain. On your post-op visit, patient describes adequate analgesia for 1 hr, pain for 2 hrs, and really sleepy for 1 hr.

- Why might this be happening?
- How can you minimize these swings?

Three days post-op, patient is ready for discontinuation of IV pain meds. Over the previous 24 hr period he has used 18 mg IV morphine.

- What would be the approximate equivalent dose if you prescribed Tylenol #3?

Notes:

ANESTHESIA OVERVIEW

Introduction to Anesthesia

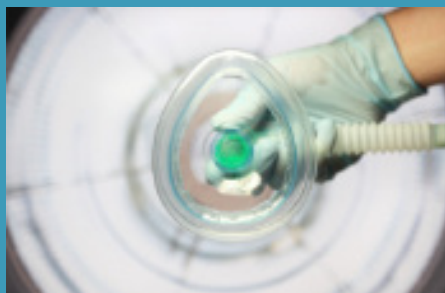
The original role of the anesthesiologist was to facilitate surgical procedures by providing analgesia and amnesia for patients in a safe manner. While this continues to be the primary responsibility of anesthesiologists, the breadth of anesthesia has now grown out of being practiced exclusively in the operating room to areas outside the OR as well as providing services as consulting specialty in many patient care areas. Anesthesiologists can now well be described as true perioperative physicians.

Anesthesiologists provide care for invasive and noninvasive procedures outside the OR including MRI, CT, ECT, cardiac catheterizations, and interventional radiological procedures. In most institutions anesthesiologists are an integral part of the cardiopulmonary resuscitation, or “code team”, and are known to be the experts in patient resuscitation and life support.

Anesthesiologists act as a consulting service for other areas of medicine.

Anesthesiologists are often called upon to provide labor analgesia and also provide care during cesarean sections. Advances in regional anesthesia and knowledge of analgesic medications provide the foundation for anesthesiologists as consultants for acute pain management. A one year fellowship allows anesthesiologists to also practice chronic pain management in the outpatient clinic setting. Likewise, a fellowship in critical care allows anesthesiologists to be excellent intensive care physicians.

Anesthesiology is fast moving field due to new drugs, new monitoring technology, and advances in surgical techniques. Its practice has changed much over the past few decades, and it is a field that requires perpetual learning and practice.



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, and 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 we've written here, but our goal again is to present you with a simple overview.

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.

PREOPERATIVE HISTORY AND PHYSICAL

Preoperative History

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 (i.e. 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. This is usually an indication for rapid sequence intubation (succinylcholine + cricoid pressure).

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.

Endocrine -

Steroids: Patients with recent steroid use may require preoperative steroids to cover secondary adrenal suppression.

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

Thyroid: Hypo/Hyper metabolic states affect the cardiovascular system, renal clearance, and thermoregulation.

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. The #1 anesthesia allergen is the non-depolarizing paralytics. The #2 class is antibiotics.

Family History - There is a rare, but serious disorder known as **malignant hyperthermia** that affects susceptible patients under anesthesia, and is heritable. Another heritable disorder is **pseudocholinesterase deficiency** which affects succinylcholine duration and may require extended postoperative ventilation.

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 (another indication for rapid sequence intubation).

Physical

While a history of a difficult intubation may be the most reliable predictor of future difficult intubations, the physical exam is also important to help predict potential problems. For the physical exam, the specific areas which are of particular importance to the anesthesiologist include the cardiovascular system, lungs, head/neck/upper airway, signs of preexisting neurological dysfunction, and signs of coagulation dysfunction.

Many tests have been proposed to help predict difficulty with intubation, but no single factor, taken independently, has been able to accomplish this goal. However, when multiple factors are taken together, the predictive value is increased. The following are some specific aspects of the head/neck/upper airway exam which can be used to help predict difficulties that may be encountered.

Head/Neck/Upper Airway Exam

Facial trauma or deformities - may make it difficult to perform laryngoscopy.

Deviated septum or nasal polyps - can pose difficulty with nasal intubation or with inserting a nasogastric tube, possibly resulting in bleeding.

Neck range of motion - the patient needs to be able to assume the sniffing position (cervical flexion and atlanto-occipital extension) so that the oral, pharyngeal, and laryngeal axes are aligned which will facilitate viewing the glottic opening. Normal patients should achieve 35 degrees or more of atlanto-occipital extension, which can be assessed by observing the angle traversed by the occlusal surface of the maxillary teeth when the head is fully extended from the neutral position. Difficulty with intubation may be predicted by a significant reduction in the ability to achieve this degree of extension or if the patient experiences any pain, tingling, or numbness during this movement.

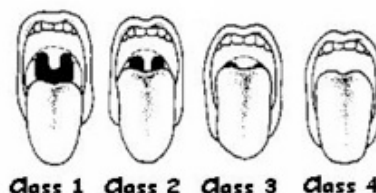
TMJ mobility and degree of mouth opening - this is important for determining the adequacy of space for manipulating the laryngoscope and endotracheal tube. Measure the inter-incisor distance. An opening of < 3 cm or 2 finger breadths will likely not provide adequate space and may result in a difficult intubation. In addition, ask the patient to move the lower incisors as high on the upper lip as possible (upper lip bite test). If the lower incisors do not reach the vermilion border of the upper lip, this may be a sign of inadequate translational movement of the TMJ, which is also necessary for successful laryngoscopy.

Dentition - It is important to note the presence of dentures, poor dentition, loose teeth, or caps, which may not tolerate digital manipulation or may be at risk of damage when the laryngoscopic blade is inserted into the mouth. Dentures should be removed before surgery. In addition, the presence of prominent maxillary incisors may result in obstruction of the view of the glottis. Conversely, edentulous patients are generally easy to intubate, but may pose difficulty with mask ventilation.

Tongue/Oropharynx - Direct laryngoscopy allows visualization of the larynx by displacing the tongue anteriorly into the mandibular space, which moves the tongue out of the line of sight. A normal sized tongue will generally fit easily into the space between the two mandibular rami. However, if the tongue is too large (macroglossia) or the mandible is too small (micrognathia), there will likely be difficulty with proper visualization of the glottis. The Mallampati classification is a method to assess the tongue size in relation to the size of the oropharynx. The test is performed by having the patient sit with their head in the neutral position, and then open their mouth as wide as possible and protrude the tongue as far as possible. They should not phonate, as this can elevate the soft palate and alter the view. A Class 3 or 4 view may be associated with difficult laryngoscopy.

The size of the mandible can be assessed by measuring the thyromental distance. This is the distance from the mentum of the mandible to the thyroid cartilage. A thyromental distance of 6 cm (approximately 3 finger breadths) or less, as often seen in patients with a receding mandible or a short neck, may indicate a possible difficult intubation. Alternatively, the sternomental distance (from mentum to sternal notch) can also be used, which assesses the size of the mandible and neck. A sternomental distance of < 13 cm may also point to difficulty with intubation.

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 than twenty-four hours without surgical intervention. An "E" is added if the case is emergent. The full details of the classification scale are also detailed later.



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, Bicitra, and/or 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.

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 monitors that we use on all 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.

In the operating room, the anesthesia machine can support non-invasive and invasive monitors. While in the majority of cases, non-invasive monitoring is sufficient, examples and indications of invasive monitors include:

- **Arterial lines for continuous blood pressure monitoring** – usually radial, but can be brachial, femoral, etc.
Used in any case where wide swings in blood pressure are expected, where tight control of blood pressure is needed, in cardiopulmonary bypass cases, or when there will be the need for multiple blood gas analyses.
- **Central venous lines for measuring CVP**- typically IJ or subclavian
Used in any case when there is the need to closely monitor the intravascular volume status or there is a need to evaluate right ventricular function.
- **Pulmonary artery catheter for measuring Wedge pressure (LVEDP)**
Used to determine RAP, PA, LVEDP, CO, and PvO₂. These measurements are helpful when faced with poor left ventricular function, valvular disease, recent MI, ARDS, massive trauma, major vascular surgeries, or when there is a critical need to accurately assess the intravascular fluid volume or the response to blood pressure interventions.
- **Transesophageal echo (TEE)** – used in many CV cases
Used to evaluate regional wall motion abnormalities indicative of myocardial ischemia, to evaluate stroke volume/ejection fraction, to evaluate cardiac valvular function, to look for intracardiac air, to monitor changes in cardiac function, or to evaluate adequacy of intravascular fluid volume.

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.

When it comes to drawing up the initial drugs, there are four categories of drugs that should be ready for each case: induction agents, sedation/analgesia drugs, reversal agents, and emergency drugs. At times, the specific drugs may vary depending on the case, but the following are most commonly used. The first three categories should be drawn up in preparation for the case, but the emergency drugs are often already prepared.

Induction Agents	
Lidocaine (1%) (10mg/mL)	Draw up in a 5cc syringe
Propofol (10mg/mL)	Draw up in a 20cc syringe
Rocuronium (10mg/mL) or Vecuronium (1mg/ml)	Draw up in a 5cc syringe Draw up in a 10cc syringe

Sedation/Analgesia Drugs	
Versed (1mg/mL)	Draw up in 3cc syringe
Fentanyl (50mcg/mL)	Draw up in 5cc syringe

Reversal Agents	
Neostigmine (1mg/mL)	Draw up in 5cc syringe
Glycopyrrolate (0.2mg/mL)	Draw up in 5cc syringe

Emergency Drugs	
*Phenylephrine (100mcg/mL)	In 10cc syringe
*Ephedrine (5mg/mL)	In 10cc syringe
*Succinylcholine (20mg/mL)	In 10cc syringe
Atropine 1mg/mL	In 3cc syringe

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.

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 the patient is 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.



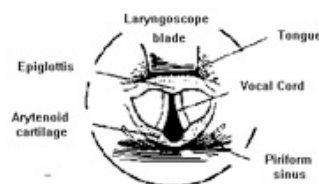
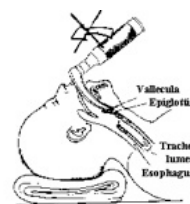
The first part of induction of anesthesia should be pre-oxygenation with 100% oxygen delivered via a face mask. The goal should be an end-tidal oxygen concentration of more than 80%, a SaO₂ of 100%, or lacking end tidal gas monitoring, at least four full tidal volume breaths with a tight fitting mask. Performing a “jaw thrust” or “chin lift” will optimize the patient’s airway for bag mask ventilation.

The reason we pre-oxygenate prior to induction and intubation is to maximize the amount of time a person can tolerate apnea without desaturating. This translates to more time available to secure the airway, which is very important if the patient turns out to have an unanticipated difficult airway. When breathing stops, the body's oxygen stores are limited to the oxygen in the blood and the oxygen in the lungs. A normal person uses approximately 250-300 mL of oxygen each minute and can desaturate in as little as 30 – 60 seconds of apnea. Within the lungs, the functional residual capacity (FRC) is approximately 3 liters in a normal person. When breathing room air (21% O₂), the FRC contains mostly nitrogen and a relatively small amount of oxygen. However, when breathing 100% O₂, this effectively replaces the nitrogen with oxygen within the FRC and creates a tremendous additional reserve of oxygen that can be used by the body. This pre-oxygenation can provide 3 – 6 additional minutes of apnea before significant O₂ desaturation occurs.

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.

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 non depolarizing 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.



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 blood pressure, pulse, EKG, O₂ saturation, temperature, end-tidal O₂, CO₂, N₂O, 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.

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.

When using nondepolarizing neuromuscular blocking agents such as Rocuronium or Cisatracurium, a peripheral nerve stimulator is used to monitor the pharmacological effects of these drugs, and the dosage can be titrated to effect. Near the end of the case, the nerve stimulator is used to assess the degree of spontaneous recovery from these drugs. Neostigmine, an anticholinesterase drug, is typically used as a reversal agent when the spontaneous recovery is occurring, as determined by the presence of twitches induced by the nerve stimulator. When utilizing a train-of-four stimulation, the greater the number of visible muscle twitches, the greater the degree of spontaneous recovery that has occurred. A lack of muscle twitches indicates the blockade at the neuromuscular junction is still too intense and the administration of neostigmine is not likely to facilitate reversal. It is also important to note that even with 4 twitches and the return of spontaneous breathing, the patient may still have up to 75% of the NMJ receptors occupied by the blocking agent. The adequacy of recovery from the neuromuscular blocking drugs can be tested clinically by the ability of the patient to maintain a head lift, leg lift or handgrip strength for > 5 seconds.

Once a patient has adequately recovered from the effects of the neuromuscular blocking agents, is able to breathe on his own, is able to follow commands, demonstrates purposeful movements, and can protect his airway, he is most likely ready to be extubated. In addition, the following physiological parameters are also used to assess readiness for extubation.

- RR > 8 & < 30/min
- TV > 5 cc/kg
- TV/RR > 10
- PaO₂ > 65-70 mmHg on FiO₂ < 40%
- PaCO₂ < 50 mmHg
- Hemodynamic stability
- Temperature at least 35 C
- NIF > -20

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.

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.

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 us to teach you what you don't understand, and get as much practice with airway management 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 ABC's is part, of any complete physician's repertoire. *Enjoy!*

COMMONLY USED MEDICATIONS

VOLATILE ANESTHETICS

- All are bronchodilators, except for desflurane which is irritating and may cause bronchospasm. Administered alone (i.e., without narcotics), inhaled anesthetics increase respiratory rate but decrease tidal volume.
- Except for halothane, inhaled anesthetics are not metabolized by the body and are eliminated by ventilation.
- All volatile anesthetics (but not nitrous oxide) are capable of triggering malignant hyperthermia (MH).
- While in many cases volatile anesthetics are used for maintenance of anesthesia, in some circumstances these drugs may be chosen to induce anesthesia such as in pediatrics cases in which the child may not tolerate IV placement awake.
- Minimum Alveolar Concentration – defines the amount of anesthetic necessary to achieve no response to surgical stimulus. 1 MAC equals the amount of anesthetic to produce no response in 50% of the population. A MAC of 1.3 is 2 standard deviations up, or where 95% don't respond. A MAC of 1.5 is the MAC BAR, where sympathetic outflow is completely blocked. Each inhalational agent has its own MAC. When using multiple agents, MAC's are additive, i.e. $\frac{1}{2}$ MAC of nitrous (52%) + $\frac{1}{2}$ MAC of Sevo (1.1%) is equal to 2.2% sevo alone.

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

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

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 L/min. Theoretical potential for renal toxicity from inorganic fluoride metabolites.

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, eye, Decreases FiO2, Increases pulmonary vascular resistance

IV ANESTHETICS

Most sedative hypnotics work through the inhibitory gamma-aminobutyric acid (GABA) neurotransmitter system in which increased chloride conductance leads to neuronal inhibition. Most IV induction agents bind to a specific site called GABAA for this inhibitory effect, and they have a rapid onset due to lipophilic properties which allow them to quickly partition into the highly perfused lipophilic brain and spinal cord. They also have short duration of action, with their termination of effect due to redistribution into less perfused tissues such as muscle and fat.

Barbiturates (e.g., thiopental)	
Decrease ICP by decrease in cerebral oxygen consumption. Since cerebral perfusion is preserved, desirable drug for neurosurgery cases. Causes respiratory and cardiac depression.	
PRO	Excellent brain protection, Stops seizures, Cheap
CON	Myocardial depression, Vasodilation, Histamine release, Can precipitate porphyria in susceptible patients

Propofol	
In adults, induction dose 1.5 to 2.5 mg/kg while continuous infusion of 100 to 200 micrograms/kg/min maintains unconsciousness. These values differ for children and for the elderly.	
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, cross reactivity in patients with egg allergy.

Etomidate	
Minimal depression of cardiovascular and pulmonary function. Ideal for patients with CVD or hemodynamic instability. Induction dose of 0.2 to 0.4 mg/kg that causes pain on injection and myoclonus. Suggested that it may suppress cortisol synthesis.	
PRO	Least myocardial effect of IV anesthetics
CON	Pain on injection, Adrenal suppression (? significance if used only for induction), Myoclonus, Nausea/Vomiting

Ketamine	
Works via antagonism of the N-methyl-D-aspartate receptor channel complex. Minimally depresses the cardiorespiratory system. Induction dose of 1 to 2 mg/kg in adults. Directly stimulates SNS and increases BP and heart rate. Increasing demand on the heart and is not a good choice for CAD patients.	
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 CMR02, Stimulation of SNS → bad for patients with compromised cardiac function, increases airway secretions

Dexmedetomidine	
Selective alpha-2 adrenergic agonist, which is used in the operating room as an adjunct to general anesthesia, or to provide sedation for awake fiberoptic intubation or for regional anesthesia. It is generally given as a loading dose of 0.5-1 mcg/kg over 10 minutes, followed by an infusion of 0.2 to 0.7 mcg/kg/hr. It produces sedative-hypnotic and analgesic effects without causing respiratory depression.	

Benzodiazepines (BDZ)	
Usually provided as premedication for sedation and anxiolysis before general anesthesia. Properties include anxiolytic effects to sedation and unconsciousness at higher doses. Midazolam (Versed) induction dose of 0.1 to 0.2 mg/kg and infusion rates of 0.25 to 1 microgram/kg per minute. BDZs produce respiratory, cardiovascular, and upper airway reflex depression and in the presence of hypovolemia, may cause significant hypotension. Reversal of the sedative action of these compounds with the competitive antagonist, flumazenil.	

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, Chlorprocaine.

Amides

Metabolized by hepatic enzymes. All have at least two "i"s in their name, eg. Lidocaine, Ropivacaine, Bupivacaine

OPIOIDS

Morphine

Depresses breathing principally by impairing the medullary response to CO₂. Also trigger the chemoreceptor trigger zone (CTZ) which may lead to nausea, and may in turn stimulate the vomiting center and produce emesis. Also, morphine decreases GI motility and propulsion, produces urinary retention, and releases histamine by stimulating basophils in the lungs and mast cells in the skin. In the CVS, morphine may produce vascular dilation, decrease SVR, and overall hypotension. It is long acting & renally excreted → active metabolite has opiate properties, therefore beware in renal failure

Demerol

Euphoria, stimulates catecholamine release, so beware in patients using MAOI's, renally active metabolite associated with seizure activity, therefore beware in renal failure

Fentanyl/Alfentanil/Sufentanil/Remifentanil

More potent than morphine, with Sufentanil being the most potent (up to 1,000x as potent). In addition, all are shorter acting than morphine, with Remifentanil being the shortest. Often used to attenuate the stress response to surgical stimulation. Low doses produce brief effect, but larger doses are long acting, increased incidence of chest wall rigidity vs. other opiates, no active metabolites, usually safe in patients with morphine allergies.

MUSCLE RELAXANTS

Depolarizing

Succinylcholine - inhibits the post-junctional receptor and passively diffuses off 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 a different 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. (Cholinergic Crisis SLUD CB2: Salivation, Lacrimation, Urination, Diarrhea, Ciliary constriction (miosis), Bronchospasm, Bradycardia.)
<i>Neostigmine</i> - shares duration of action with glycopyrrolate (see below) <i>Edrophonium</i> - shares duration of action with atropine (see below) <i>Physostigmine</i> - 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
<i>Glycopyrrolate</i> - used in conjunction with neostigmine, does not cross BBB

IV FLUIDS

HOW MUCH?

Type \ HR	1	2	3	4
Maintenance per hour (4, 2, 1 rule, or kg +40 in anyone over 20 kg)	1	1	1	1
Deficit (Hrs NPO x Maintenance)	1/2	1/4	1/4	-
Insensible Loss (3-15 cc/hr : case dependent)				
Estimated blood loss (1:1 colloid, 3:1 crystalloid)				

ALLOWABLE BLOOD LOSS

The allowable loss is calculated by multiplying the blood volume (BV) by the percent from starting hematocrit (HCTs) to threshold hematocrit (HCTt) for transfusion.

$$ABL = BV \times ((HCTs - HCTt) / HCTs)$$

Blood volume is determined by multiplying the weight by a constant.

- Neonates = 90 cc/kg
- Infants = 80 cc/kg
- Adult men = 60 cc/kg
- Adult women = 50 cc/kg

Example

A 50 kg woman comes in after fasting for 12 hours for elective surgery. Her pre-op hematocrit was 35. You decide that in order to transfuse she must have a hematocrit less than 25. Over the course of the surgery she loses 250 cc’s of blood each hour for 3 hours. She has only minimal blood loss during the last hour of her 4 hour surgery.

Type \ HR	1	2	3	4
Maintenance per hour (4, 2, 1 rule, OR kg +40 in anyone over 20 kg)	90	90	90	90
Deficit (Hrs NPO x Maintenance) 12 x 90 = 1080	540	270	270	-
Insensible Loss (3-15 cc/hr : case dependent)	8	8	8	8
Estimated blood loss (1:1 colloid, 3:1 crystalloid)	Col – 250 Crys- 750	Col – 250 Crys- 750	Col – 250 Crys- 750	-
Total crystalloid	1388	1110	1110	98

Additionally, she should be transfused as she passed her threshold for transfusion during the third hour. Since that point was close to the end of surgery, transfusion probably could be held off until arrival at PACU since transfusion reaction is not easily noticed while under general anesthesia.

ASA CLASSIFICATION

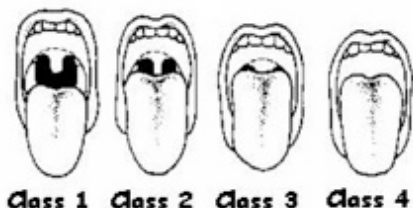
The purpose of the grading system is simply to assess the degree of a patient’s “sickness” or “physical state” prior to selecting the anesthetic or prior to performing surgery. Describing patients’ preoperative physical status is used for recordkeeping, for communicating between colleagues, and to create a uniform system for statistical analysis. The grading system is **not** intended for use as a measure to predict operative risk. The modern classification system consists of six categories, as described below.

ASA Physical Status (PS) Classification System*		
ASA PS Category	Peroperative Health Status	Comments, Examples
ASA PS 1	Normal healthy patient	No organic, physiologic, or psychiatric disturbance; excludes the very young and very old; healthy with good exercise tolerance
ASA PS 2	Patients with mild systemic disease	No functional limitations; has a well-controlled disease of one body system; controlled hypertension or diabetes without systemic effects, cigarette smoking without chronic obstructive pulmonary disease (COPD); mild obesity, pregnancy
ASA PS 3	Patients with severe systemic disease	Some functional limitation; has a controlled disease of more than one body system or one major system; no immediate danger of death; controlled congestive heart failure (CHF), stable angina, old heart attack, poorly controlled hypertension, morbid obesity, chronic renal failure; bronchospastic disease with intermittent symptoms
ASA PS 4	Patients with severe systemic disease that is a constant threat to life	Has at least one severe disease that is poorly controlled or at end stage; possible risk of death; unstable angina, symptomatic COPD, symptomatic CHF, hepatorenal failure
ASA PS 5	Moribund patients who are not expected to survive without the operation	Not expected to survive > 24 hours without surgery; imminent risk of death; multiorgan failure, sepsis syndrome with hemodynamic instability, hypothermia, poorly controlled coagulopathy
ASA PS 6	A declared brain-dead patient who organs are being removed for donor purposes	

*ASA PS classifications from the American Society of Anesthesiologists

The Mallampati Classification is based on the structures visualized with maximal mouth opening and tongue protrusion in the sitting position (originally described without phonation, but others have suggested minimum Mallampati Classification with or without phonation best correlates with intubation difficulty).

Class 1: soft palate, fauces, uvula, pillars



Class 2: soft palate, fauces, portion of uvula

Class 3: soft palate, base of uvula

Class 4: hard palate only

QUICK REFERENCE / REVIEW

PRE-ANESTHESIA EVALUATION

Cardiac Patient – decreased exercise tolerance important sign; if able to climb >2 flights of stairs, cardiac reserve probably intact

- Post-MI: infarction risk stabilizes at 5-6% after 6 months
 - Perioperative MI mortality 20-50%
 - If no prior MI, perioperative risk 0.13%
 - Occur in 48-72 hrs post-op
 - No elective surgery within 6 months of MI
- Prior Cardiac Surgery or PTCA is **not** contraindication to surgery
- Contraindication to surgery = MI <1 month, uncompensated CHF, severe AS or MS
- Evaluation
 - Major risk: unstable coronary syndrome
 - Intermediate risk: mild angina, prior MI, CHF, DM
 - Minor risk: age, abnormal EKG, arrhythmia, decreased functional capacity, stroke, uncontrolled HTN
- Studies: EKG, Holter, stress test, technetium 99m, thallium imaging, coronary angiography

COPD

- Explain obstruction
- Determine severity and responsiveness to albuterol, get PFT's, CXR if highly symptomatic
- Increased risk if pre-op PT's <50% predicted
- Also helpful to determine home O2 requirement, hospitalization history, and which medicines used how often

DM

- Watch for signs and symptoms of myocardial dysfunction, cerebral ischemia, HTN, renal disease
- Correct hypoglycemia, DKA, and lytes before surgery
- Maintain glucose between 120-180
- Reglan + H2 blocker
- Signs of autonomic neuropathy – impotence, HTN, neurogenic bladder, orthostasis
- May also develop arthropathy leading to difficult cervical extension. If cannot put palms and fingers flat together, likely to have more difficult airway due to lack of extension.

RAPID SEQUENCE INTUBATION

Rapid Sequence Intubation is used in anyone at risk for aspiration. Major difference is that there is no bag-mask ventilation following induction, as this could introduce air into the GI track causing vomiting.

- Preparation: check Allergies, Medications, Past med hx, Last meal, Events surrounding incident (AMPLE). Also check supplies and monitors.
- Preoxygenate: 100% for 3 minutes
- Pre-treat: opioids to reduce sympathetic response to intubation, raglan and bicitra to reduce risk of gastric aspiration syndrome
- Paralysis and anesthesia: IV induction followed immediately by succinylcholine, often use propofol due to its anti-emetic action
- Pass tube: immediately following fasciculations from succinylcholine
- Post-tube management: tape tube, opioids, etc, etc.

EXTUBATION CRITERIA

- Tidal volume > 5cc/kg
- Respirations spontaneous and >8/min
- NIF of -10 to -15
- Patient showing purposeful movement
- Temperature of 35 C or greater
- Hemodynamic stability
- PaO₂ ≥ 60 on FiO₂ 40, Pco₂ ≤ 55 mmHg

LARYNGOSPASM

- Children at especially high risk
- Try to break first by giving high positive pressure
- If cannot break, must use succinylcholine to paralyze patient to bag-mask or re-intubate.

SURVIVAL GUIDE

- Standard Cart Setup
- Trauma Cart Setup
- Pediatric Cart Setup
- OB Standard Cart Setup
- Dr. Choi's OB Recipe
- Regional Nerve Block Set Up
- Local Anesthetic Maximum Dosages
- Inhalational Agents
- Common Drug Dosages
- Adult CPR Drugs
- Difficult Airway Algorithm
- ACLS Tachycardia Protocol
- ACLS Pulseless Arrest Protocol
- Pediatric Potpourri
- Blood and Narcotic Potpourri

STANDARD CART SETUP

“MOST MAIDS”

- Machine** Machine check every morning
- Oxygen** Spare tank (green) on back of machine, gauge should read >1000 when open
- Suction** Functional, with appropriate tip (soft suction, Yankauer)
- Temp/Tape** Check room temp (warm for babies and burn patients)
 Bair hugger blankets and machine in room
 Fluid warmer if needed
 Micropore tape pre-cut and folded for eyes
 Pink tape available for tube
 Extra roll of micropore taped to machine
- Monitors** Pulse oximeter with probe attached
 NIBP cord with extra cuffs in drawer
 EKG on bed (except 180° cases) with pads attached
 Esophageal stethoscope or skin temp available
 BIS monitor with alcohol wipes and gauze if indicated
 +/- A-line, Central line, PA catheter, TEE, cerebral oximeter if indicated
- Airway** Mask attached to circuit
 Oral airway available with tongue depressor
 Soft bite block, NG tube if indicated
 7.0 and 7.5 ETT w/ stylet, balloon checked, with 10mL syringe attached
 Laryngoscope with Mac/Miller blade attached, light checked
 LMA, lube, tongue depressor, with 20mL syringe attached if planning to use
 FastTrak, glidescope, fiberoptic scope available if appropriate
 Ambu bag on machine
- IVs** IV kit: tourniquet, 4x4s, tegaderm, alcohol wipes, 16 & 18 & 20g IVs
 NS with blood tubing +/- warmer, stopcocks, and extension primed
- Drugs** *Label, date, and initial all syringes!*
 Phenylephrine 100mcg/mL (diluted or get pre-made from pharmacy)
 Nitroglycerine 50mcg/mL (dilutioned or get from pharmacy)
 Ephedrine 5mg/mL (9mL NS + 1mL 50mg/mL ampule)
 Atropine 0.4mg/mL (draw 2.5 mL)
 +/- esmolol (10mL)
 Propofol (20mL) or Etomidate (10mL)
 Succinylcholine (5-10mL)
 Rocuronium or Cistracurium or Vecuronium (if planning to use)
 Midazolam (2mL)
 Fentanyl (5mL)
 Lidocaine (5-10mL)
- Special** Chair
 Gloves
 Stethoscope

TRAUMA CART SETUP

“MOST MAIDS”

- Machine** Machine check in the morning and afternoon
- Oxygen** Spare tank (green) on back of machine, gauge should read >1000 when open
- Suction** Functional, with Yankauer attached
- Temp/Tape** Bair hugger blankets and machine in room
 Fluid warmer and Belmont or Level One set up
 Micropore tape pre-cut and folded for eyes
 Pink tape available for tube
 Extra roll of micropore taped to machine
- Monitors** Pulse oximeter with probe attached
 NIBP cord with extra cuffs in drawer
 EKG on bed with pads attached
 Esophageal stethoscope or skin temp available
 BIS monitor with alcohol wipes and gauze
 A-line setup with 500mL NS, pressure bag, and tubing (not spiked), monitor cable, and bag of A-line supplies (from line cart), sterile gloves
- Airway** Mask attached to circuit
 Oral airway available (purple) & tongue depressor
 Tongue depressor, soft bite block, NG tube
 7.0 and 7.5 ETT w/ stylet, balloon checked, with 10mL syringe attached
 Laryngoscope with Mac/Miller blade attached, light checked
 LMA, FastTrak, glidescope, fiberoptic scope available
 Ambu bag on machine
 Jet vent available and functional
- IVs** IV kit: tourniquet, 4x4, tegaderm, alcohol wipes, 16 & 18GA IVs
 NS with blood tubing +/- warmer, stopcock, and extension (NOT spiked)
 Central line kit available in room
- Drugs** *Label, date, and initial all syringes!*
 Phenylephrine 100mcg/mL (double dilution or get from pharmacy)
 Nitroglycerine 50mcg/mL (double dilution or get from pharmacy)
 Ephedrine 5mg/mL (9mL NS + 1mL 50mg/mL ampule)
 Atropine 0.4mg/mL (draw 2.5 mL)
 +/- esmolol (10mL)
 Propofol (20mL) or Etomidate (10mL) available, not drawn up
 Succinylcholine (5-10mL)
 Rocuronium or Cistracurium or Vecuronium drawn up (10mL)
 Empty 3mL Midazolam syringe
 Empty 5mL Fentanyl syringe
 Lidocaine (5-10mL)
 Pepcid, Reglan, and Bicitra available, not drawn up
- Special** Chair
 Gloves
 Stethoscope
 Chart (check consent)

****For Neurotrauma Room: add Lasix, Mannitol,**

PEDIATRIC CART SETUP

“MOST MAIDS”

- Machine**
 - Machine check every morning
 - Pediatric circuit connected
 - Adjust vent settings to size of patient (Pressure ctrl)
 - Change BP monitor reading to child or neonate
 - Set carrier gas to N2O for mask induction
 - Sevoflurane vaporizer full for mask induction
- Oxygen**
 - Spare tank (green) on back of machine, gauge should read >1000 when open
- Suction**
 - Functional, with appropriate tip (soft suction, smaller sizes on peds cart)
- Temp/Tape**
 - Check room temp (warm for babies and burn patients)
 - Bair hugger blankets and machine in room
 - Underbody Bair hugger for babies and small children
 - Fluid warmer if needed
 - Heating lamp if needed
 - Micropore or paper tape pre-cut and folded for eyes
 - Pink tape and thick white tape available for tube
 - Extra roll of micropore taped to machine
- Monitors**
 - TWO Pulse oximeters with appropriately sized probe attached
 - NIBP cord with appropriately sized cuff
 - 3-lead EKG on bed with small pads attached
 - Esophageal stethoscope (check size) or skin temp available
 - +/- Pediatric size A-line, Central line if indicated
- Airway**
 - Mask attached to circuit (check size)
 - Oral airways available (three different sizes)
 - Tongue depressor (small), soft bite block, NG tube (check size)
 - ETT stylet, balloon checked, with syringe attached if cuffed (check size)
 - Laryngoscope with Mac/Miller blade attached, light checked (check size)
 - LMA, lube, tongue depressor, with syringe attached if planning to use (check size)
 - FastTrak, glidescope, fiberoptic scope available if appropriate
 - Ambu bag on machine
- IVs**
 - No bubbles in any pediatric IV!**
 - IV kit: tourniquet, 4x4s, tegaderm, alcohol wipes, 22 & 24GA IVs
 - CHLA T-piece primed with NS
 - 500mL bag with microdripper OR Buretrol primed
 - Extra saline flushes for pushing drugs
- Drugs**
 - Label, date, and initial all syringes!*
 - IV Atropine 0.4mg/mL (draw unit dose)
 - IM Atropine 0.4mg/mL (draw unit dose, attach 24GA needle)
 - IV Succinylcholine 20mg/mL (draw unit dose)
 - IM Succinylcholine 20mg/mL (draw unit dose, attach 24GA needle)
 - Epinephrine 1 or 10mcg/mL (10mL syringe)
 - Propofol 20mg/mL (draw about 2x what you expect to use)
 - Rocuronium or Cistracurium or Vecuronium (if planning to use)
 - Lidocaine 10mg/mL (draw 1 mg/kg)
 - Fentanyl (talk to your attending about dilution)
 - PO or IV Midazolam in pre-op
- Special**
 - Chair
 - Gloves
 - Stethoscope

ETT Sizes	
<i>(leak should be 15-20 mmHg)</i>	
<i>(in general, use uncuffed tubes for <10 years)</i>	
<1500g	2.5
1500-5000g	3.0
Infant	3.0-3.5
6-12 months	3.5-4.0
12-20 months	4.0
>20 months	4.0 + Age (years)/4

Laryngoscope Blade Sizes	
Neonate/premature	Miller 0
<6-8 months	Miller 1
9 months-2 years	Wis-Hipple 1.5
2.5-5 years	Miller 2
>5 years	Mac 2

Length of Insertion of ETT	
<1 year	6 + Weight (Kg)
>1 year	12 + Age (years)/2

Weight estimation	
28 weeks	1 Kg
22-30 weeks	1 Kg +/- 100g/wk from 28
<1 year	4 Kg + ½ Age (months)
1 year-teen	10 Kg + Age (years) x 2

Fluid Requirement (mL/hr)	
4 mL/kg for the first 10kg	
2 mL/kg for the next 10kg	
1 mL/kg for the remaining kgs	

Estimated Blood Volume (mL/kg)	
Preterm	90-105
Term	78-86
1-12 months	73-78
1-3 years	74-82
4-6 years	80-86
7-18 years	83-90

Volume of PRBC replacement (mL) = EBV x Desired Hctx (Actual Hct / Hct PRBC)

OB STANDARD CART SETUP

“MOST MAIDS”

- | | |
|------------------|---|
| Machine | <input type="checkbox"/> Machine check every morning (we dare u to beat Dr. Choi to it) |
| Oxygen | <input type="checkbox"/> Spare oxygen tank (green) on back of machine, gauge should read >1000 when open |
| Suction | <input type="checkbox"/> Functional, with appropriate tip (soft suction, Yankauer) |
| Temp/Tape | <input type="checkbox"/> Micropore tape pre-cut and folded for eyes
<input type="checkbox"/> Pink tape available for tube
<input type="checkbox"/> Extra roll of micropore taped to machine |
| Monitors | <input type="checkbox"/> Pulse oximeter with probe attached
<input type="checkbox"/> NIBP cord with extra cuffs in drawer
<input type="checkbox"/> EKG on bed with pads attached
<input type="checkbox"/> Skin temp available |
| Airway | <input type="checkbox"/> Face Mask available
<input type="checkbox"/> 7.0 and 7.5 ETT (for crash section) w/ stylet, balloon checked, with 10mL syringe attached
<input type="checkbox"/> Laryngoscope with Mac/Miller blade attached, light checked
<input type="checkbox"/> LMA, lube, tongue depressor, with 20mL syringe attached if planning to use
<input type="checkbox"/> Ambu bag on machine |
| IVs | <input type="checkbox"/> IV kit: tourniquet, 4x4, tegaderm, alcohol wipes, 16 & 18GA IVs
<input type="checkbox"/> NS with blood tubing +/- warmer, stopcock, and extension primed |
| Drugs | <input type="checkbox"/> <i>Label, date, and initial all syringes!</i>
<input type="checkbox"/> Phenylephrine 100mcg/mL (double dilution or get from pharmacy): draw 3 syringes
<input type="checkbox"/> Ephedrine 5mg/mL (9mL NS + 1mL 50mg/mL ampule): draw 3 syringes
<input type="checkbox"/> Propofol (20mL) or Etomidate (10mL) (if planning to use)
<input type="checkbox"/> Succinylcholine (5-10mL)
<input type="checkbox"/> Rocuronium or Cisatracurium or Vecuronium (if planning to use)
<input type="checkbox"/> Midazolam (2mL)
<input type="checkbox"/> Fentanyl (5mL)
<input type="checkbox"/> Methergine 0.2mg IM available
<input type="checkbox"/> Oxytocin (40units): bolus after delivery of fetus
<input type="checkbox"/> Hemabate 250 mcg IM available: DO NOT GIVE IV, may cause bronchospasm |
| Special | <input type="checkbox"/> Epidural & Spinal tray with sterile gloves
<input type="checkbox"/> Chair |

DR. CHOI'S OB RECIPE

- | | |
|------------------|--|
| Cesarean Section | <input type="checkbox"/> Spinal: 0.75% Bupivacaine 1.6 mL + Duramorph 0.4 mL (0.2mg) ± Fentanyl (20-25 mcg)
<input type="checkbox"/> Epidural: 2% lidocaine w/ 1:200K Epinephrine, NaHCO3 1 mL per 10mL of Lidocaine (15-30mL) bolus in 5 mL increments; Give 4 mg Duramorph after delivery |
| Labor Analgesia | <input type="checkbox"/> Spinal: 0.25% Bupivacaine 0.5 mL + Fentanyl 25 mcg
<input type="checkbox"/> Epidural: 0.25% Bupivacaine 10-12 mL in divided boluses
<input type="checkbox"/> Maintenance: 0.1 % Bupivacaine infusion @ 10-12 mL/hr |
| Vaginal Delivery | <input type="checkbox"/> Epidural (perineal dose) sitting dose: 2-3% Chloroprocaine (5-15mL) in 5mL increments |
| Cesarean/BTL | <input type="checkbox"/> Epidural: 3% Chloroprocaine (20-30 mL) in 5 mL increments
<input type="checkbox"/> Spinal: 5% lidocaine (1.2mL) ± Fentanyl 25 mcg |

REGIONAL NERVE BLOCK SET UP

- Machine
 - Turn on ultrasound laptop
 - Twitch monitor with attached ECG pad
- Oxygen
 - Face mask connected to wall oxygen
- Monitors
 - Pulse oximeter
 - BP cuff
- Drugs
 - Fentanyl (sedation)
 - Midazolam (sedation)
 - Lidocaine (for skin infiltration); attach 27G needle
 - Ropivacaine in 20 mL syringe x 2 (draw up total 30 mL) with epinephrine 1:400,000 (draw up 0.075 mL Epi (75mcg) in Tb syringe and add to ropivacaine); connect 20 mL syringes with T-connector
- Supplies
 - Sterile towels
 - Sterile Gloves
 - Chloraprep
 - Chart (check consent)
 - Marking pen for confirmation of site
 - Ultrasound probe plastic condom
 - Gel for ultrasound probe
 - Stimulating needle (2", 4", or 6") or Indwelling Catheter kit (if applicable)

LOCAL ANESTHETICS: MAXIMUM DOSAGES

Drug	Plain (mg/kg)	w/ Epi (mg/kg)
Lidocaine	3-4	7
Bupivacaine	2.5	3
Ropivacaine	2.5	2.5
Mepivacaine	4.5	7

COMMON DRUGS AND DOSAGES

Induction Agents (mg/kg)	
Propofol	1.50-2.50
Etomidate	0.2-0.3
Ketamine	1.00-3.00
Sodium Thiopental	3.00-5.00

Reversal Agents (mg/kg)	
Neostigmine	0.05-0.07
Glycopyrrolate	0.01

Muscle Relaxants (Intubating doses in mg/kg)	
Succinylcholine	1.00-1.50
Rocuronium	0.60-1.20
Cisatracurium	0.20
Vecuronium	0.08-0.10
Pancuronium	0.10

Resuscitation Drugs - bolus doses	
Phenylephrine (mcg)	100-200
Ephedrine (mg)	5-10
Atropine (mg)	0.50-1.00
Nitroglycerine (mcg)	50-150
Epinephrine (mcg)	10-100
Naloxone (mcg)	40-400

ADULT CPR DRUGS *(Drugs listed in italics may also be given via endotracheal tube)*

Drug	Dose	Indication
Adenosine	6 mg IV push Repeat with 12 mg IV push if ineffective	Stable narrow complex tachycardia (contraindicated in WPW)
Amiodarone	300 mg IV Repeat with 150 mg IV if needed, up to 2.2g/24 hours	Pulseless VT/VF Stable VT or uncertain wide complex tachycardia and narrow complex tachycardia
<i>Atropine</i>	1 mg IV Repeat with 0.5 mg every 3-5 minutes up to a total dose of 3 mg	Asystole or slow PEA Bradycardia
Diltiazem	15-20 mg (0.25 mg/kg) IV over 2 minutes Repeat with 20-25 mg in 15 minutes if needed 5-15 mg/hr infusion, titrate to HR	Stable narrow complex tachycardia (contraindicated in WPW)
Dopamine	2-10 mcg/kg/min infusion	Bradycardia while awaiting pacer
<i>Epinephrine</i>	1 mg IV Repeat every 3-5 minutes 2-10 mcg/min infusion	Pulseless cardiac arrest Bradycardia while awaiting pacer
Esmolol	0.5 mg/kg IV load 0.05-0.3 mg/kg/min infusion	Stable narrow complex tachycardia (contraindicated in WPW)
<i>Lidocaine</i>	1-1.5 mg/kg IV Repeat with 0.5 mg/kg IV if needed up to 3 mg/kg	Pulseless VT/VF
Magnesium	1-2 g IV	Torsades des Pointes
Metoprolol	5 mg IV Repeat every 5 minutes if needed up to 15 mg	Stable narrow complex tachycardia (contraindicated in WPW)
<i>Vasopressin</i>	40 U IV	To replace 1st or 2nd dose of epinephrine in pulseless VT/VF, asystole, or PEA
Verapamil	2.5-5 mg IV over 2 minutes Repeat with 5-10 mg over 15-30 minutes if needed up to 20 mg	Stable narrow complex tachycardia (contraindicated in WPW)

DIFFICULT AIRWAY ALGORITHM

1. Assess the likelihood and clinical impact of basic management problems:

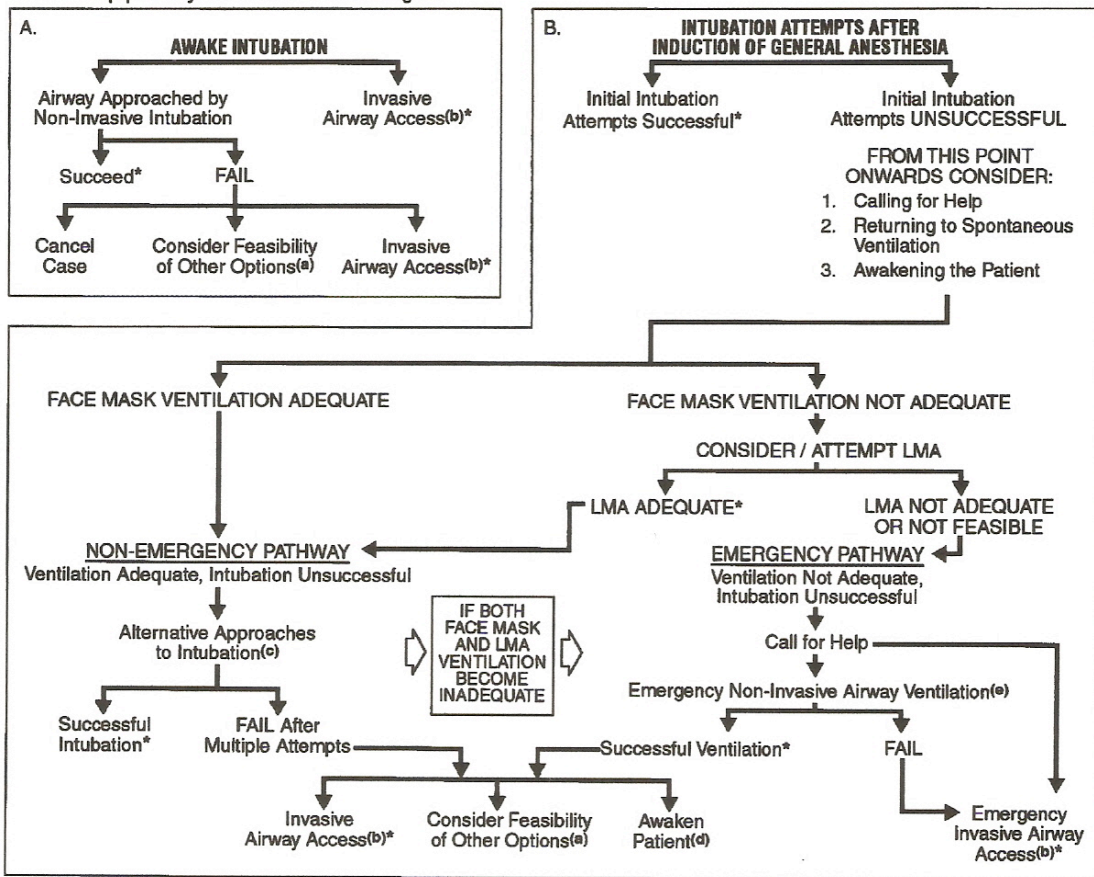
- A. Difficult Ventilation
- B. Difficult Intubation
- C. Difficulty with Patient Cooperation or Consent
- D. Difficult Tracheostomy

2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management

3. Consider the relative merits and feasibility of basic management choices:

- A. Awake Intubation vs. Intubation Attempts After Induction of General Anesthesia
- B. Non-Invasive Technique for Initial Approach to Intubation vs. Invasive Technique for Initial Approach to Intubation
- C. Preservation of Spontaneous Ventilation vs. Ablation of Spontaneous Ventilation

4. Develop primary and alternative strategies:



* Confirm ventilation, tracheal intubation, or LMA placement with exhaled CO₂

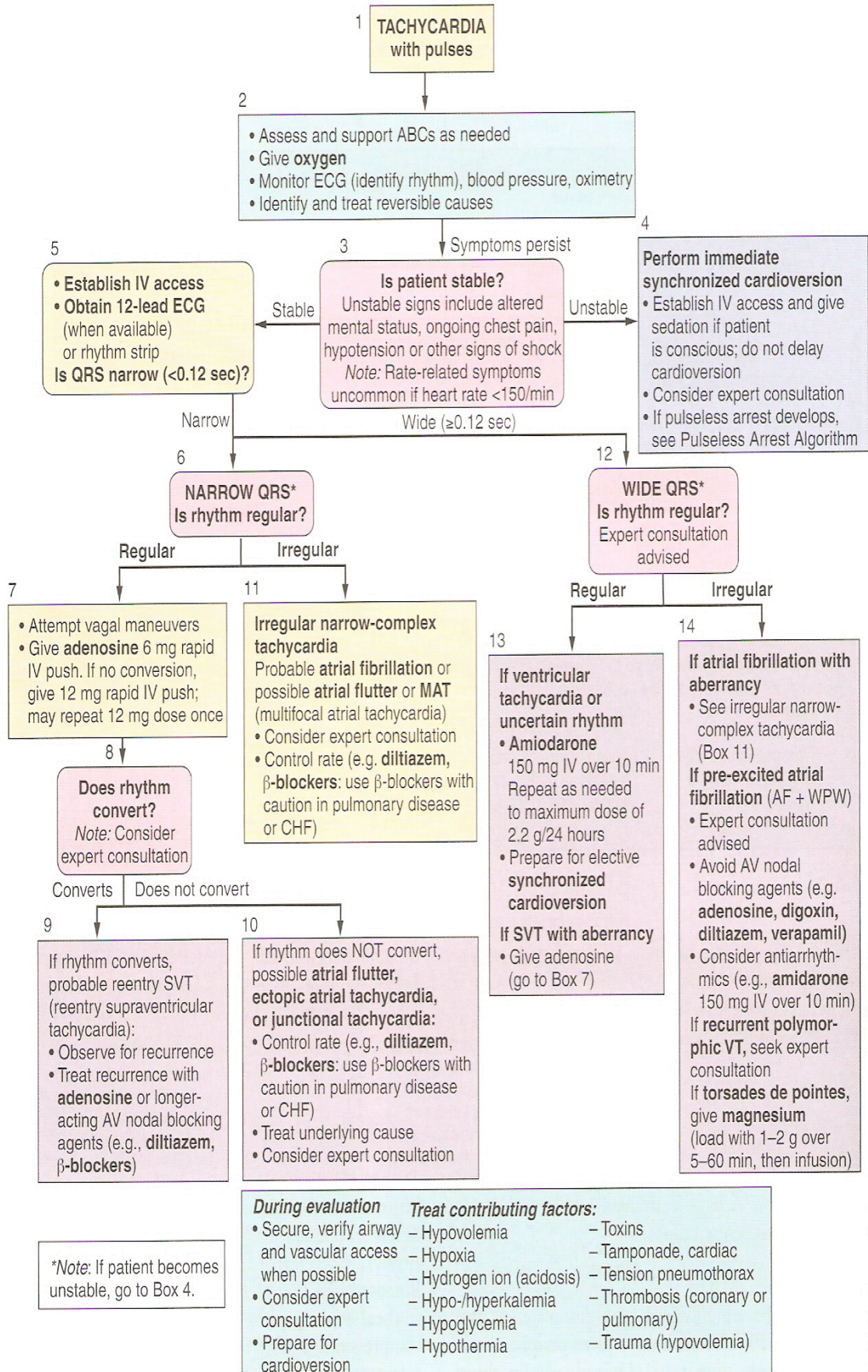
a. Other options include (but are not limited to): surgery utilizing face mask or LMA anesthesia, local anesthesia infiltration or regional nerve blockade. Pursuit of these options usually implies that mask ventilation will not be problematic. Therefore, these options may be of limited value if this step in the algorithm has been reached via the Emergency Pathway.

b. Invasive airway access includes surgical or percutaneous

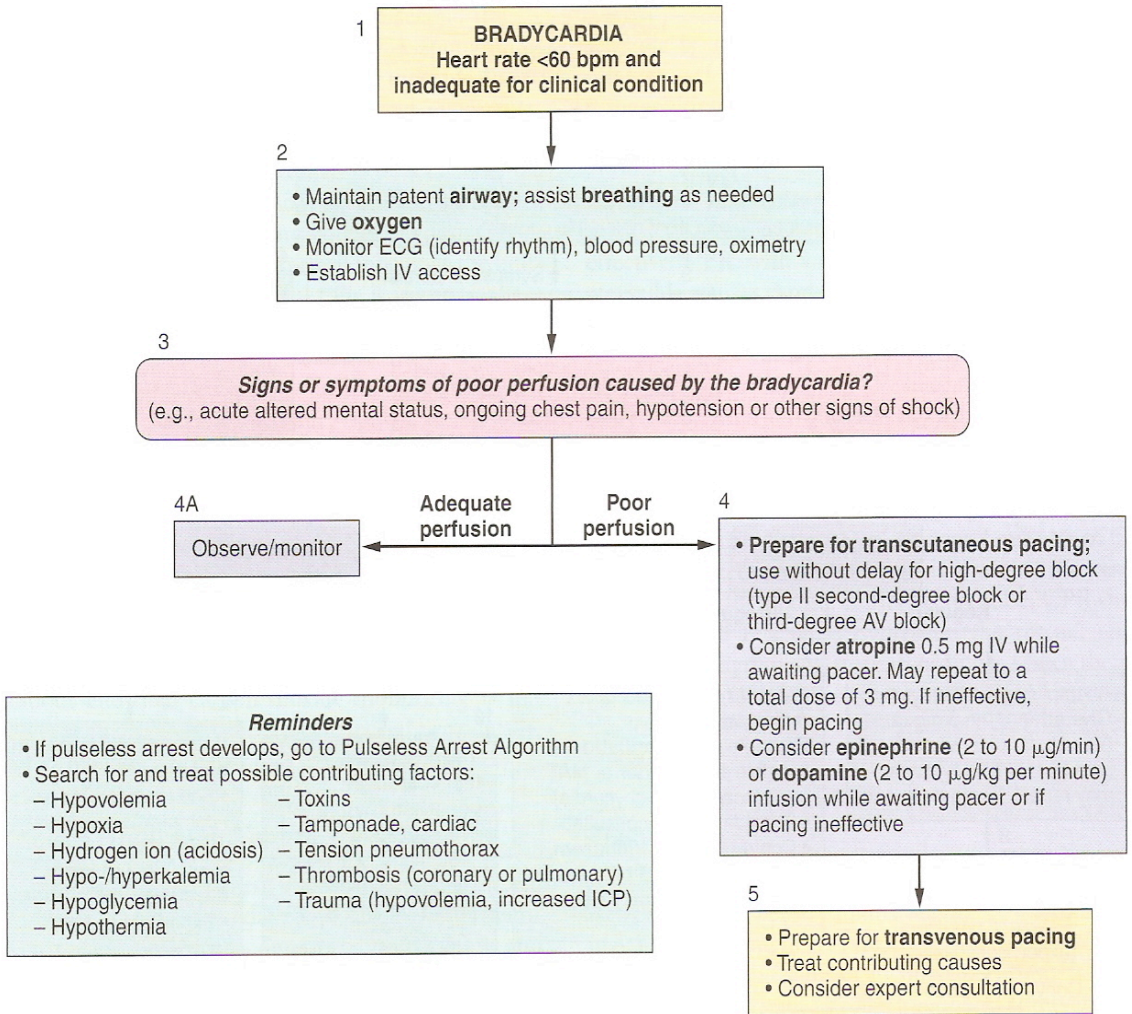
c. Alternative non-invasive approaches to difficult intubation include (but are not limited to): use of different laryngoscope blades, LMA as an intubation conduit (with or without fiberoptic guidance), fiberoptic intubation, intubating stylet or tube changer, light wand, retrograde intubation, and blind oral or nasal intubation.

d. Consider re-preparation of the patient for awake intubation or canceling surgery

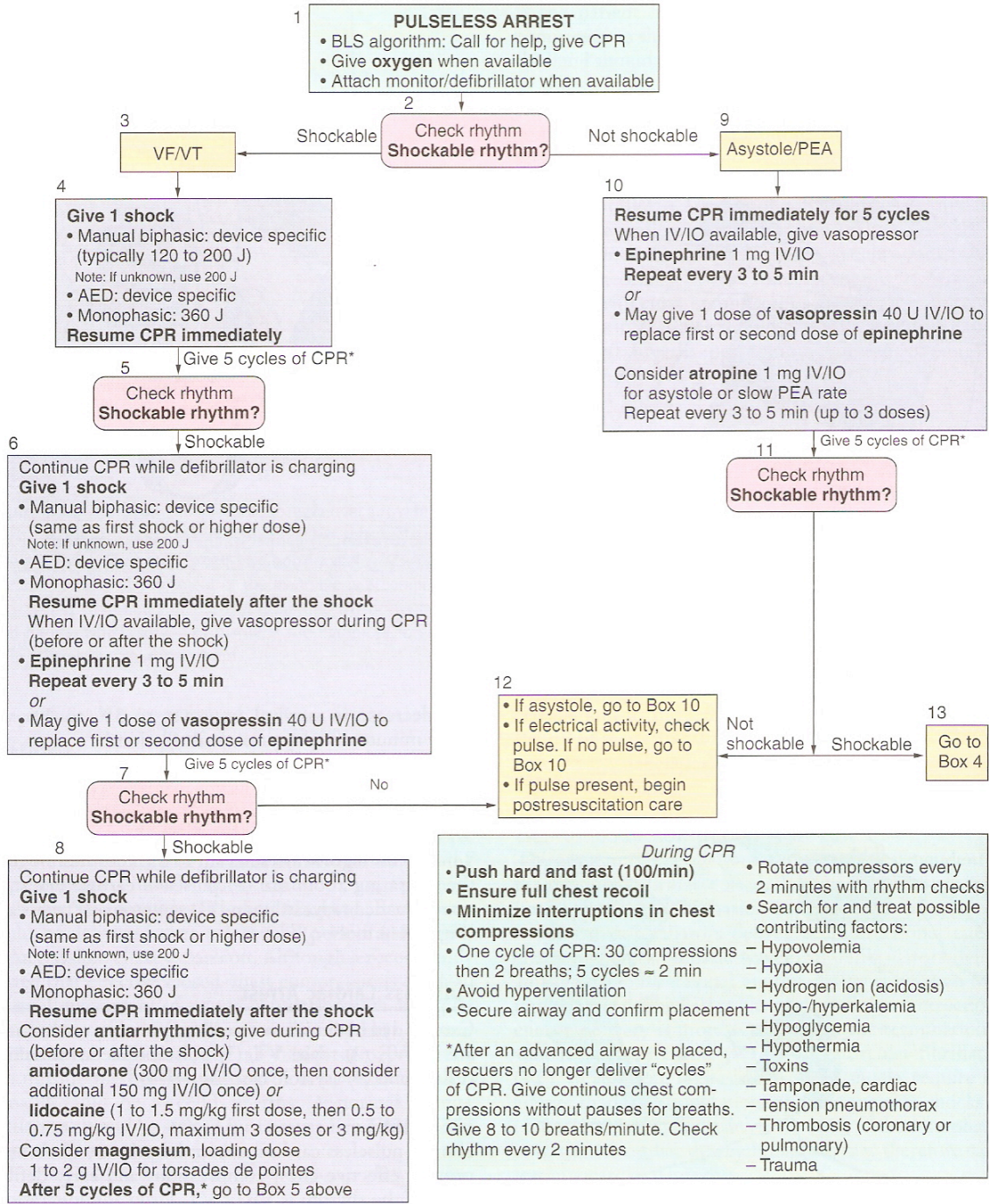
ACLS TACHYCARDIA PROTOCOL



ACLS BRADYCARDIA PROTOCOL



ACLS PULSELESS ARREST PROTOCOL



PEDIATRIC POTPOURRI

Normal Values according to age

Age	HR	BP	RR	Wt(kg)	ETT	Blade
Newborn	120-180	55-80/30-50	50-60	3.2	3.0	0
6 mo.	140-260	65-108/43-7	24-40	7.5	3.5	1
12 mo.	90-150	65-108/43-70	24-40	10	4.0	1
2-3 yrs.	80-130	78-113/45-78	24-32	12	4.5	1.5-2.0
4-6 yrs.	80-120	78-113/45-78	22-28	16-20	5.0	1.5-2.0
6-8 yrs.	75-110	80-120/53-8	20-24	20-24	5.5-6.0	2
10-12 yrs.	70-110	90-130/55-85	14-20	30-40	6.0-6.5	2-3
14-16 yrs.	60-105	95-144/58-88	12-20	40-60	6.5-7.0	3

Cuffed ETT= (age/4) +3 (>2 yrs)

UnCuffed ETT= (age/4) +4 (>2yrs)

ESTIMATE WEIGHT BY AGE (kg)

$$\text{kg} = (\text{age}+4) \times 2$$

ETT (Cuffed <2yrs)	
<1 kg	2.5 mm
1-2 kg	3.0 mm
>3kg	3.5-4.0 mm
FT	3.0 mm
1 yr	3.5-4.0 mm
2 ys	4.5-5.0 mm

Depth = ETT x 3 or (age/2) +12 (>2yr)

Depth 1 yr = 12cm (at lip)

Newborn = 10cm

Premie = 1kg – 7cm

2kg – 8cm

3kg – 9cm

4kg – 10cm

LMA wt(kg)	
1	<10
1.5	<15
2	<20
2.5	25-35
3	30-70
4	>70

NPO Guidelines
2 hrs – clears
4 hrs – breast milk
6 hrs - formula
8 hrs – solids

Hypotension in Peds	
Newborn	SBP < 50
1 mo.	SBP < 60
1-10 yrs	SBP = 70 + 2(age)
<i>*20% above or below NL is Hypertension or Hypotension</i>	

Normal Intracardiac Pressures (mmHg)

	Newborn	Child
RA (mean)	0-4	2-6
RV	65-80/0-6	15-25/3-7
PA	65-80/35-50	15-25/10-16
PW(mean)	6-9	8-11
LA(mean)	3-6	5-10
LV	65-80/0-6	90-110/65-75

MAP = systolic + (2/3)diastolic

SVR – 1200-1500dyne/sec/cm²

PVR – 100-300 dyne/sec/cm² or 1-3 wood units

CI – 2.8-4.2 L/min/m²

CVP Access
<10kg - 4F/8cm
10-30kg - 4 F/12cm
>30kg - 5F/15cm

BLOOD AND NARCOTIC POTPOURRI

Estimated Blood Volume (Circulating Blood Volume)

Age	EBV (ml/kg)
Preterm	100
FT newborn	90
Infant	80
School age	75
Adult	70

ALLOWABLE BLOOD LOSS EQUATION

$$EBV = wt(kg) \times \text{Estimated Blood Volume}$$

$$ABL = \frac{EBV \times (\text{original Hct} - \text{lowest acceptable Hct})}{\text{Average Hct}}$$

ESTIMATED HOURLY FLUID REQ: 4,2,1 RULE

4 ml/kg for first 10kg
 plus 2 ml/kg for next 10kg
 plus 1 ml/kg for each kg thereafter
**in adults: Wt(kg) + 40ml = ml/hr for maintenance*

ESTIMATION OF EPIDURAL DEPTH

$$= 18 + (1.5 \text{ age in yrs})$$

**use with caution in adults*

Narcotic Conversions
100mcg Fentanyl
1 mg epidural Morphine 0.1 mg intrathecal Morphine
30mg po Morphine (3:1 PO:IV)
30 mg PO Hydrocodone
20 mg PO Oxycodone (3:2 Oxycodone:Morphine)
200 mg PO Codeine (10:1 Oxycodone:Codeine)
6 mg Hydromorphone (5:1 Hydromorphone:Morphine)
1.2 mg IV Hydromorphone (1:3-5 PO:IV)
6 mg PO Morphine = 50 mg Meperidine
30 mg PO Morphine = 250 mg PO Meperidine = 75 mg IV Meperidine

Fentanyl Patch	PO Morphine	IV Morphine
25 mcg	~ 75 mg/day	~18 mg/day
50 mcg	~150 mg/day	~25 mg/day
75 mcg	~235 mg/day	~40mg/day
100 mcg	~300 mg/day	~58 mg/day