RIVERSIDE COUNTY REGIONAL MEDICAL CENTER

ANESTHESIA DEPARTMENT

Medical Student

Orientation Handbook

Last Revised: July 27, 2015
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GENERAL INFORMATION AND EXPECTATIONS

FIRST DAY:
Access the program website, rcrmc-ar.org, prior to your first day to complete all required paperwork. At 7 a.m. report to the GME Office located on the first floor for your employee ID badge and scrub access. Proceed to room F2026, on the second floor, and report to Malin Cannon.

Come prepared for OR duties (i.e. no open toed shoes). If planning on applying to this program, please provide a photo and CV.

PARKING: On your first day, you may park in visitor parking. The GME office will provide you with a parking pass for student or employee parking. Parking rules are strictly enforced. Any questions regarding a citation can be addressed at the Security Office at the Cactus Avenue entrance to the medical center.

SCHEDULING REQUESTS: All scheduling issues need to be submitted in writing and discussed with Dr. Dominguez, or if not available with other attending staff members. Any approved schedule change needs to be documented in writing and submitted to Dr. Dominguez.
Students are not expected to work on county holidays.

SICK DAYS/EMERGENCIES: If you are unexpectedly unable to complete your assigned shift it is your responsibility to first try to find a replacement among your colleagues. If this is not possible contact the attending on-call through the OR front desk (951-486-4572). Again, all schedule changes must be coordinated and approved with Dr. Dominguez when possible.

EDUCATION SCHEDULE: You are responsible to attend all educational activities. It is unacceptable to be late for morning lectures. Monthly educational schedules are posted on the corkboard outside the anesthesia secretary’s office (Room F-2027) and on the website. The only exceptions to the mandatory attendance are the Wednesday monthly exam, resident only meetings, and department meeting. You are also not expected to attend if you are not scheduled to work.

OR ASSIGNMENTS: Students are expected to arrive at the same time as the residents in the morning to help set up the rooms. OR assignments for the following day are usually made around 1:00-2:00pm – at this point the student is encouraged to note the type of case they will be involved in (and perform any necessary reading to prepare) as well as the anesthesia provider that they are paired with. The student is encouraged to contact that anesthesia provider the day before for advice on reading material as well as what time to arrive the next morning.

CASE ASSIGNMENTS: Case assignments are made for the following day around 2:00 pm and medical students are assigned to specific rooms. The OR schedule once assigned will be in the wall box next to room F-2028 (attending office). The schedule may change without notice – you are responsible for checking it again in the morning.

C-LOCKERS: Familiarize yourself with the C-lockers in the ORs. They contain spinal kits, head cradles, oral/nasal RAE tubes, ABG syringes, circuits, suction apparatus, gloved pulse oximetry monitors, etc.

PAPERWORK: A complete anesthesia record is not only important from a medico-legal standpoint – it reflects the quality of anesthesia given. All notes need to be detailed and legible. There are 6 pieces of paperwork to be completed for each case:

1. anesthesia pre-op/ H & P note
2. anesthesia record
3. post anesthesia record with orders (this is not necessary if your patient is a direct admit to the ICU or the patient received MAC without a spinal anesthetic)
4. computer CQI data form and pharmacy/ central supply billing sheet
5. pink anesthesia billing form
6. Pyxis printout with a senior resident or your attending’s signature.

All paperwork must have the patient’s name, PF number, billing number, and date of service.
Please refer to the Anesthesia Documentation and Record Keeping section of this document.

DRESS CODE: RCRMC scrubs must be worn any time in the operating arena, outside scrubs are not acceptable. When leaving the OR suites (cafeteria, floor pre-ops) head and shoe covers must be removed, and a cover gown must be worn (lab coat, scrub coat).
EDUCATION OVERVIEW

The following is an outline. Specific assignments and topics often change. Refer to the current week’s educational schedule online at rcrmc-ar.org or attached to the corkboard outside of the anesthesia department secretary’s office for up to date information.

Morning Reports
6:40 – 7:00 Monday, Tuesday & Thursdays
Resident, Dental Anesthesia Resident, or Medical Student facilitated
Topics assigned or chosen by presenter including M&Ms and Journal Reviews
Mandatory for all Residents, Rotators and Medical Students to attend
Lecture schedule is posted on the Anesthesia Department bulletin board

Morning Reports –
6:30 – 7:00 on Fridays
Mandatory for all Residents, Rotators and Medical Students to attend

Wednesday Lectures
7:00 – 8:00 Wednesdays (except monthly exam days)
Lange’s Clinical Anesthesia is current required reading for residents
Mandatory for all Residents, Rotators and Medical Students to attend

Monthly Exams
7:00 – 7:30 the last Wednesday of every month
Typically contains 25 questions covering the month’s lectures and review questions from prior month’s topics
Mandatory for all Anesthesia Residents/Optional for students

Journal Clubs
Occur bimonthly
Mandatory for all residents and medical students

READING MATERIAL

The curriculum for daily/monthly lectures will follow Morgan and Mikhail’s Clinical Anesthesiology, 5th edition.

However, the 3rd edition of this book is available to all rotating students and will be left in the anesthesia department lounge on a daily basis. Most of the chapter titles from the 5th edition (i.e.: Neuromuscular Blocking Agents, chapter 11) will have a very similar chapter in the 3rd edition – it just might not be the same chapter number. Students will be able to prepare adequately for lectures by matching the assigned chapter in the 5th edition with the corresponding chapter in the 3rd edition that is available in the anesthesia lounge.

The disclaimer below is a suggestion of reading material that references the Morgan & Mikhail 5th edition – however, the majority of these chapters are relatively unchanged in the 3rd edition if students do not have access to the 5th edition. Also, most of the anesthesia residents at RCRMC own the 5th edition and would be more than happy to copy chapters for you.
This packet is BY NO MEANS complete; it is an attempt to organize the information in a more compact fashion. Students should reference more complete sources for a true understanding of the material. In order to function effectively on the anesthesia service, students should have a working knowledge of the following chapters in *Morgan & Mikhail’s Clinical Anesthesiology 5th edition*:

Chapter 4: The Anesthesia Machine
Chapter 5: Cardiovascular Monitoring
Chapter 6: Noncardiovascular Monitoring
Chapter 7: Pharmacologic Principles
Chapter 8: Inhalation Agents
Chapter 9: Intravenous Anesthetics
Chapter 10: Analgesic Agents
Chapter 11: Neuromuscular Blocking Agents
Chapter 12: Cholinesterase Inhibitors & Other Pharmacologic Antagonists to NMBDAs
Chapter 13: Anticholinergic Drugs
Chapter 14: Adrenergic Agonists & Antagonists
Chapter 15: Hypotensive Agents
Chapter 16: Local Anesthetics
Chapter 17: Adjuncts to Anesthesia
Chapter 18: Perioperative Assessment, Premedication, & Perioperative Documentation
Chapter 19: Airway Management
Chapter 39: Anesthesia for Trauma & Emergency Surgery
Chapter 40: Maternal & Fetal Physiology
Chapter 41: Obstetric Anesthesia
Chapter 42: Pediatric Anesthesia
Chapter 45: Spinal, Epidural, & Caudal Blocks
Chapter 49: Management of Patients with Fluid & Electrolyte Disturbances
Chapter 50: Acid-Base Management
Chapter 51: Fluid Management & Blood Component Therapy
Chapter 52: Thermoregulation, Hypothermia, & Malignant Hyperthermia

A possible study strategy involves learning (at least) this packet BEFORE the start of your rotation, and then reading one of the above chapters each night after you are dismissed from the OR.

**Additional Chapters that are not required but would greatly increase your understanding are:**

Chapter 20: Cardiovascular Physiology & Anesthesia
Chapter 21: Anesthesia for Patients with Cardiovascular Disease
Chapter 23: Respiratory Physiology & Anesthesia
Chapter 24: Anesthesia for Patients with Respiratory Disease
Chapter 26: Neurophysiology & Anesthesia
Chapter 27: Anesthesia for Neurosurgery
Chapter 30: Anesthesia for Patients with Kidney Disease
Chapter 32: Hepatic Physiology & Anesthesia
Chapter 33: Anesthesia for Patients with Liver Disease
Chapter 46: Peripheral Nerve Blocks
PREOPERATIVE PATIENT EVALUATION

GOALS:
- Assess anesthetic risks and devise means of reducing complications
- Interview the surgical patient to evaluate his medical and surgical problems by obtaining a thorough medical history and performing a directed physical exam
- Establish a rapport with the patient through which:
  1. plans for pre-, peri-, and post-operative management are formulated;
  2. the pharmacological and psychological needs of your patient are determined;
  3. the appropriate types of anesthesia and application methods are discussed, including and explanation of the inherent risks or complications from anesthesia (where applicable);
  4. consent is obtained
- Ensure the patient is in optimal condition for surgery

WHAT TO INCLUDE:
1. ID the patient and chart. Record age, weight (in kg), and height.
2. Review the patient’s prior anesthetic records, relevant lab results, old EKGs, etc.
3. ISSUES TO ADDRESS:
   - Ask the patient to describe the operation he will be having. Ask the patient or legal guardian for consent to receive blood products, if necessary.
   - Allergies (especially drug allergies; also latex, plastic tape) and the reaction the patient has
   - Medications the patient is taking on a regular basis (prescription & non-prescription); any prior or current steroid use
   - What medications did the patient take today? (BP meds, antibiotics, insulin, etc.)
   - Smoking – alcohol- drug history
     - If + for amphetamines, consider having an EKG done
   - CARDIAC: chest pain? SOB? DOE? If yes, ask about pillow orthopnea. Exercise tolerance?
     HTN, high cholesterol, arrhythmias? What prior diagnostic work-up have you had?
   - LUNGS: asthma, TB, recent URI? If yes, how long did it last and did you take antibiotics, especially important in patients with pre-existing lung disease and pediatric patients.
   - Prior surgeries and any anesthetic problems encountered; has anyone in your family had problems with anesthesia – such as high fevers or prolonged recoveries?
   - NPO status
   - Pregnancy test, if applicable
   - This is an appropriate time to have the patient empty his bladder if you do not anticipate using a Foley catheter.
4. All patients over 45 years of age should have a baseline EKG, as well as anyone whose history or cardiac exam indicates one.
5. Perform a brief physical exam.
6. Assign an ASA classification.
7. Explain to the patient your anesthetic plan, and upon request by the patient, review the complications of this type of anesthesia, including complications specifically related to the patient’s co-morbidities, social history, etc.
8. Present the patient to your attending and discuss your anesthetic plan.

The choice of an anesthetic is based on the surgical procedure, the patient’s physical status and any underlying medical illness, as well as the expressed desire of the patient. The anesthesiologist is in the important position of recognizing patterns of risk and developing and executing a plan to reduce the possibility of complications during the medical management period.
A. ASA PHYSICAL STATUS CLASSIFICATION:

<table>
<thead>
<tr>
<th>PHYSICAL STATUS 1</th>
<th>normal, healthy patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICAL STATUS 2</td>
<td>patient with mild systemic disease (diabetes, controlled hypertension, obesity, anemia, age extremes, pregnancy, illegal drug history)</td>
</tr>
<tr>
<td>PHYSICAL STATUS 3</td>
<td>patient with severe systemic disease that limits activity, which may or may not be related to the reason for surgery (poorly controlled hypertension, diabetes with end organ damage, vascular complications, COPD which limits activity, prior MI, angina)</td>
</tr>
<tr>
<td>PHYSICAL STATUS 4</td>
<td>patient with incapacitating systemic disease which is a constant threat to life (CHF, renal failure, persistent angina, advanced pulmonary or hepatic dysfunction)</td>
</tr>
<tr>
<td>PHYSICAL STATUS 5</td>
<td>moribund patient not expected to survive 24 hours with or without an operation (ruptured aneurysm, cerebral trauma, resuscitative efforts)</td>
</tr>
<tr>
<td>PHYSICAL STATUS 6</td>
<td>brain-dead patient for organ donation</td>
</tr>
<tr>
<td>EMERGENCY OPERATION (E)</td>
<td>any patient in whom an emergency operation is required</td>
</tr>
</tbody>
</table>

B. AIRWAY EXAM:

Your airway exam and clinical judgment are the most important part of the preoperative evaluation. However, never be too confident about your ability to intubate a patient and ALWAYS have a back-up plan.

A difficult airway can be:
- Difficult to oxygenate and ventilate
- Difficult to intubate
- Difficult to perform a surgical airway

**MALLAMPATI CLASSIFICATION:** (Upright maximal tongue protrusion test)
Have the patient sit upright, head in neutral position, mouth open as wide as possible, tongue protruding maximally—do not have the patient say “ah” (this may falsely elevate the soft palate). This gives you the relationship between the tongue and oral cavity size.

<table>
<thead>
<tr>
<th>CLASS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Soft palate, uvula, tonsillar pillars visible</td>
</tr>
<tr>
<td>II</td>
<td>Soft palate, more than base of uvula, but tonsillar pillars hidden by tongue</td>
</tr>
<tr>
<td>III</td>
<td>Soft palate, only base of uvula</td>
</tr>
<tr>
<td>IV</td>
<td>Only hard palate visible</td>
</tr>
</tbody>
</table>

**THYROMENTAL DISTANCE:** (aka: Anterior Mandibular Space) Have the patient fully extend the neck. Measure the distance from the mandible to the thyroid notch. If the distance is less than 3-4 finger breadths (less than 6 cm), there may be difficulty visualizing the glottis during laryngoscopy. A desirable value of greater than 6 cm will usually correlate with the ability to move the tongue out of the way and into the thyromental area during direct laryngoscopy to visualize the glottis.

**ATLANTO-OCCIPITAL JOINT EXTENSION:** Have the patient extend the neck (normal is 35 degrees). This is important to achieve the “sniffing position” during intubation.

**INCISOR GAP:** Have the patient open the mouth. This opening should span at least 2-3 fingerbreadths or 5-6 cm. This is the area for blade insertion during direct laryngoscopy.

**ADDITIONAL PHYSICAL EXAM:**
ANATOMIC CHARACTERISTICS
- Short neck with a small mouth and a full set of teeth
- Receding lower jaw
- Protruding upper incisors
- A long, high-arched palate
- Tumors within the oral cavity
- Prominent thyroid cartilage (associated with anterior airway)

MOUTH
- Buckteeth
- Missing, decaying, chipped, or loose teeth, dental prostheses
- Macroglossia
- TMJ mobility – patient should be able to open the mouth 2-3 finger breadths (at least 2.5 cm).

NECK
- Cervical Spine Mobility: normal range of flexion/extension is approximately 35 degrees but this will decrease as a person ages

SCARS:
- Old tracheostomy scar (associated with tracheal stenosis)

MEDICAL CONDITIONS:
- ARTHRITIS: decreased range of neck mobility with increased risk of atlantoaxial joint instability, possible CRICOARYTENOID DISEASE
- DOWN’S SYNDROME: may have atlantoaxial joint instability and large tongue
- INFECTIONS
- OBESITY/ PREGNANCY: enlarged chest may inhibit laryngoscopy; may also see redundant airway tissue
- TRAUMA: increased risk of cervical spine injuries, facial bone fractures, intra-oral damage

PREDICTORS OF DIFFICULT MASK VENTILATION:
- BMI > 26
- Age > 55 years old
- Facial hair
- Edentulous
- History of snoring or obstructive sleep apnea
GRADES OF LARYNGOSCOPIC VIEW (Cormack & Lehane):

GRADE I  visualization of the laryngeal aperture (glottis)
GRADE II visualization of the posterior portion of the laryngeal aperture
GRADE III visualization of the epiglottis only
GRADE IV visualization of the soft palate only- no epiglottis or glottis structure visible
## Risks of General Anesthesia

### Most common risks/side effects of GA:
- Nausea and vomiting
- Hoarseness/ sore throat
- Dental injury
- Vocal cord dysfunction

### Peripheral neuropathy of extremities
Nerve injury during anesthesia most commonly occurs with the ulnar nerve, followed by the brachial plexus, due to malpositioning. Lower extremity nerve complications are most likely to occur from improper lithotomy positioning (common peroneal nerve).

### Cardiovascular
Cardiovascular complications account for 25-50% of deaths following non-cardiac surgery. The most important preoperative risk factors are a history of recent MI (less than 6 months) and evidence of CHF.

<table>
<thead>
<tr>
<th>Time post-MI to surgery</th>
<th>Re-infarction Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>30%</td>
</tr>
<tr>
<td>4-6 months</td>
<td>15%</td>
</tr>
<tr>
<td>6 months</td>
<td>6%</td>
</tr>
</tbody>
</table>

The highest incidence of perioperative re-infarction is on the 3rd postoperative day. The mortality rates reported for such perioperative infarcts are usually over 50%.

### Pulmonary
Risk factors likely to increase postoperative pulmonary complications include restrictive or obstructive lung disease, history of smoking, age > 65 years, and the site of surgery (abdominal or thoracic). A recent or a current URI represents an increased risk due to an increased incidence of laryngospasm and decreased ability to clear secretions. Aspiration pneumonia accounts for a majority of anesthetic deaths.

### Hepatic
The patient with pre-existing liver disease has an increased risk due to decreased ability to metabolize drugs, complications of cirrhosis, and associated coagulopathies.

### Renal
The patient with acute or chronic renal insufficiency may be unable to eliminate many of the anesthetic drugs used. Volatile anesthetics depress renal function (decreased urine flow/ renal blood flow/ GFR)

### Stroke

### Pregnancy
A possibility of teratogenesis caused by anesthetic agents in the 1st trimester leads to a high fetal risk. Studies suggest that among pregnant women who undergo nonobstetrical surgery, there is an increased incidence in spontaneous abortions, premature births, and infants with low birth weights. It is generally recommended to avoid anesthesia during the first trimester as this is the time of maximum organogenesis. Nitrous oxide is the only inhaled anesthetic shown to be directly teratogenic in animals. Avoid the use of diazepam due to its association with cleft lip and palate.

### Allergic Drug Reactions
Muscle relaxants (most common), antibiotics, etc.

### Recall
There is a risk of awareness under anesthesia of approximately 1% in general surgery cases with a frequency of about 3-7% in C-section patients.

### Death
Numerous studies (none from the U.S.), have suggested that the risk of death from anesthesia may be between 1:10,000 and 1:200,000.

**As a general rule:** There are no firm guidelines as to whether a patient needs to be told of each and every specific risk associated with general or regional anesthesia. Each patient is unique, with distinct concerns and different capacities towards understanding, comprehending, and accepting the potentialities of anesthesia. Some patients have no desire to hear the complications of anesthesia; however, it is prudent to somehow explain to even the most unreceptive of patients the risks involved. Perhaps equating the risk of injury or death from anesthesia to the risks inherent in everyday activities, such as riding in a car or crossing a street, will help explain to the patient in an understandable and non-threatening manner.
<table>
<thead>
<tr>
<th></th>
<th># OF HOURS SINCE LAST PO INTAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADULTS</strong></td>
<td></td>
</tr>
<tr>
<td>Fatty meals</td>
<td>8</td>
</tr>
<tr>
<td>Colored liquids/ light meal</td>
<td>6</td>
</tr>
<tr>
<td>Clear liquids</td>
<td>2</td>
</tr>
<tr>
<td><strong>PEDIATRICS</strong></td>
<td></td>
</tr>
<tr>
<td>Solids</td>
<td>8</td>
</tr>
<tr>
<td>Formula</td>
<td>6</td>
</tr>
<tr>
<td>Breast milk</td>
<td>4</td>
</tr>
<tr>
<td>Clear liquids</td>
<td>2</td>
</tr>
</tbody>
</table>
A. **BLOOD PRESSURE MONITORS:** Systolic blood pressure can be determined by palpation, a doppler probe, auscultation, oscillometry (used in our OR), or arterial tonometry. Adequate oxygen delivery to vital organs must be maintained during anesthesia. Unfortunately, instruments to monitor specific organ perfusion and oxygenation are complex, expensive, and often unreliable; for that reason, an adequate arterial blood pressure is assumed to predict adequate organ blood flow. However, blood flow also depends on vascular resistance (Flow = pressure/resistance). Even if the pressure is high, when the resistance is also high, the flow can be low. Thus, arterial blood pressure should be viewed as an indicator – but not a measure – of organ perfusion. The accuracy of any method of blood pressure measurement that involves a blood pressure cuff depends on the proper cuff size. Indications for invasive arterial blood pressure monitoring by catheterization of an artery (most commonly the radial artery) include induced current or anticipated hypotension, wide blood pressure deviations, end-organ disease necessitating precise beat-to-beat blood pressure regulation, and the need for multiple arterial blood gas measurements.

B. **EKG:** All patients should have intraop EKG monitoring – there are no contraindications. Electrocardiography detects change in electric potentials as myocardial cells depolarize and repolarize. This is important for intraoperative detection of dysrhythmias, ischemia, and conduction disturbances. A pre-induction assessment of the patient’s rhythm is vital to patient care. To interpret ST segment changes properly, the EKG must be standardized so that a 1-mV signal results in a deflection of 10mm on a standard strip monitor. Our monitors have automated ST segment analysis, but this “number” should be considered as part of a clinical picture. Commonly accepted criteria for diagnosing myocardial ischemia include a flat or down sloping ST-segment depression exceeding 1mm, 80msec after the J point (end of QRS complex), particularly in conjunction with T-wave inversion. ST-segment elevation with peaked T waves can also represent ischemia. Wolff-Parkinson-White syndrome, bundle-branch blocks, extrinsic pacemaker capture, and digoxin therapy may preclude the use of ST-segment information.

C. **CAPNOGRAPH:** This determines the end-tidal CO$_2$ and confirms ventilation. Capnography is the gold standard for determination of endotracheal intubation. Capnographs sample gas near the endotracheal tube and measure CO$_2$ via infrared absorption. The shape of the capnograms provides additional information. Please refer to Faust’s Anesthesiology Review Chapter 92.

![Figure 36-18 Examples of capnography waves.](https://example.com/capnography.png)

A, Normal spontaneous breathing. B, Normal mechanical ventilation. C, Prolonged exhalation during spontaneous breathing. As CO$_2$ diffuses from the mixed venous blood into the alveoli, its concentration progressively rises (see Fig. 36-19). D, Increased slope of phase III in a mechanically ventilated patient with emphysema. E, Added dead
space during spontaneous ventilation. **F.** Dual plateau (i.e. tails-up pattern) caused by a leak in the sample line. The alveolar plateau is artificially low because of dilution of exhaled gas with air leaking inward. During each mechanical breath, the leak is reduced because of higher pressure within the airway and tubing, explaining the rise in the CO₂ concentration at the end of the alveolar plateau. This pattern is not seen during spontaneous ventilation because the required increase in airway pressure is absent. **G.** Exhausted CO₂ absorbent produces an inhaled CO₂ concentration greater than zero. **H.** Double peak for a patient with a single lung transplant. The first peak represents CO₂ from the transplanted (normal) lung. CO₂ exhalation from the remaining (obstructed) lung is delayed, producing the second peak. **I.** Inspiratory valve stuck open during spontaneous breathing. Some backflow into the inspired limb of the circuit causes a rise in the level of inspired CO₂. **J.** Inspiratory valve stuck open during mechanical ventilation. The "slurred" downslope during inspiration represents a small amount of inspired CO₂ in the inspired limb of the circuit. **K** and **L.** Expiratory valve stuck open during spontaneous breathing or mechanical ventilation. Inhalation of exhaled gas causes an increase in inspired CO₂.

**D. PULSE OXIMETRY:** This determines arterial blood saturation by differences in absorption of oxyhemoglobin and deoxyhemoglobin. The pulse oximeter emits infrared light at two wavelengths, 660 nm and 940 nm. Oxyhemoglobin absorbs the 940 nm light more strongly, while deoxyhemoglobin absorbs the 660 nm light. The ratios are empirically plotted to estimate O₂ saturation. **CAUTION:** Inaccuracy may occur in the following cases: during electrocautery; in disease states with dyshemoglobinemia (COHb, MetHb); during dye injections (methylene blue, indigo carmine); and with motion artifact. Please refer to Faust's Anesthesiology Review Chapter 94, or Morgan/Mikhail Chapter 6.

**E. VAPORIZERS:** Volatile anesthetics are delivered at precise concentrations by vaporizers. Halothane, isoflurane, and sevoflurane are given via variable bypass vaporizers. These divert a fraction of the delivered gas to become saturated. The concentration of the anesthetic is determined by the flow ratio—that is, the fraction of diverted, saturated gas over the total gas delivered. The flow ratio is variable and each vaporizer is calibrated for varying percent of anesthetic. Different anesthetics are standardized on a potency scale known as MAC (minimum alveolar concentration). Each vaporizer is calibrated for that unique anesthetic and is inaccurate if anesthetics are switched (i.e. putting sevoflurane in an isoflurane vaporizer). Desflurane is unique: because of its low boiling point, its vaporizer is pressurized and heated. Delivery is accomplished using a differential pressure transducer.
SETTING UP YOUR ROOM

“MS-MAIDS”

M - MACHINES; MASK

- Turn on machine
- Perform machine check
- Check CO₂ absorbant (purple discoloration = exhaustion)

S - SUCTION

- Connect yankauer suction tip

M - MONITORS

- Turn on other monitors

A - AIRWAY

- Tubes: ETT X 3 (7.5/8.0/8.5 For Men; 6.5/7.0/7.5 For Women)
- Stylettes: In ETTs
- Oral Airways (In General, 100 Mm For Men And 90 Mm For Women)
- Laryngoscopes & Blades X 2 (Mac 3, Mac 4, Miller 2, Miller 3)
- Tape, Temperature Probe
- Special airway devices as necessary: Bougie, LMAs, Fastrach LMA, fiberoptic, Glidescope, etc.

I - IV

- Ensure adequate flow
- Setup if necessary: appropriate gauge IV catheter(s), alcohol preps, tape, tourniquet, primed IV bag set up

D - DRUGS

- Benzodiazepine (versed)
- Opioid (fentanyl, morphine, remifentanil, dilaudid, etc.)
- Lidocaine
- Induction agent (propofol, etomidate, ketamine, sodium thiopental)
- Neuromuscular blocking agent (succinylcholine, rocuronium, vecuronium, cisatracurium, pancuronium)
- Emergency drugs (phenylephrine, ephedrine, atropine, epinephrine)
- Reversal agents (glycopyrrolate, neostigmine)
- Infusions as necessary

S - SPECIALS

- Nerve stimulator
- A-line transducer and kit
- Hotline setup
- Warming blanket, K-pad, warming lights
- Central line kits and CVP transducer
**MASK VENTILATION**

- Being able to mask ventilate a patient appropriately and effectively is vital to the practice of anesthesiology.
- Predictors of difficult mask ventilation: BMI >26, Age >55, facial hair, edentulous, history of snoring/obstructive sleep apnea.
- Technique for mask ventilation: mask should be held in provider’s left hand. Mask is placed on the patient's face starting with the bridge of the nose and then rolling caudad. The provider should hold the mask using a “C” shape with his/her thumb and index fingers, with the middle finger on the angle of the mandible. It is important to keep the middle, ring, and small fingers on the mandible and not to gather excess neck tissue in this area – this will help prevent iatrogenic airway obstruction. The provider should not push the mask into the patient’s face in order to form a seal; rather, the patient’s face should be lifted into the mask. The jaw should be lifted upward towards the ceiling by upward pressure on the angle of the mandible, which can help prevent redundant pharyngeal tissue causing obstruction. The definitive measure of successful mask ventilation is mist in the mask, and observance of adequate tidal volume administration on the ventilator.
- It is important to avoid corneal abrasions/eye injury during mask ventilation. This can be accomplished by taping eyes before ventilation, or following confirmation of the ability to ventilate (one could argue that if the provider cannot breathe for the patient, the care of the patient’s eyes is secondary).

**INTUBATION**

- Snap open the blade on the laryngoscope so that the light appears.
- Grasp the handle in your left hand so that the blade is below your hand and perpendicular with your arm (like grasping the top of the letter “L”).
- With your right hand, tilt the patient’s head gently back, allowing the mouth to open (Sniffing position).
- Place the blade in the right side of the patient’s mouth below the tongue. Gently slide the blade to the midline position, pushing the tongue over to the left.
- Lift the handle up and away from yourself, exposing the pharynx. Do not lever back and bring the handle towards yourself – you may damage the patient’s teeth.
- As you expose the pharynx, locate the epiglottis. If you need more exposure, relax the handle downwards, advance the blade further, and lift up and away again.
- If you are using a curved blade (Macintosh #3 or #4), the tip of the blade should be placed in the vallecula, the area immediately preceding the epiglottis. Lifting up and away indirectly elevates the epiglottis, allowing visualization of the vocal cords. For a straight blade (Miller #2 or #3), “pick up” the epiglottis with the blade tip so that lifting up and away elevates the epiglottis directly.
- The vocal cords frame the larynx and tracheal opening. Once recognized, they are usually unmistakable. You may need to maneuver the cricoid cartilage with your right hand to obtain a better view of the cords. A nurse/assistant can then perform the optimal cricoid position for you as you continue to intubate. Take the endotracheal tube in your right hand and insert it down the right side of the mouth, rotating the tube so that the natural curve of the ETT brings its tip towards the opening. (Note: Placing the ETT in the middle of the mouth usually obscures your vision of the cords.) It is important to visualize the ETT passing between the cords. Continue to advance the ETT until the cuff is no longer visible or the 2nd black mark on an uncuffed ETT passes the cords. If you are using a stylette, it should be removed before the ETT is advanced any further to avoid tracheal damage. However, it is vital to retain control over the ETT when an assistant is removing the stylette, as accidental dislodging of the ETT can occur. Gently relax and remove the laryngoscope from the mouth while keeping the ETT in place.
- ***Remember, the BEST method for confirmation of ETT placement is direct visualization of it passing through the cords.*** Secondary confirmation techniques include mist in the ETT, chest rise, +EtCO2, equal bilateral breath sounds, etc. (see below).
- Rapid Sequence Intubation: intubation technique used to prevent aspiration in high risk patients. This technique modifies induction technique so that the patient is not ventilated, as this can exacerbate potential aspiration risk. Cricoid pressure is applied until a definitive airway is established. A modified RSI is an induction in which the ability to ventilate is verified prior to administration of a neuromuscular blocking agent (ideal in patients that are high risk for
aspiration but in whom there is a concern about the provider’s ability to ventilate. Succinylcholine is commonly used (due to its quick onset of action), but high dose rocuronium is also an option for patients in whom succinylcholine is contraindicated. The goal is to achieve rapid paralysis so ventilation of the patient can be avoided until a definitive airway is secured.

- Indications for a Rapid Sequence Intubation (RSI): patients at high risk for aspiration, active nausea/vomiting, acute abdominal disease (appendicitis, cholecystitis, small bowel obstruction, etc.), significant opioid use (usually for pain control – can cause constipation/decreased intestinal motility), pregnancy, hiatal hernia, etc. etc.

<table>
<thead>
<tr>
<th>TRACHEA SIZES</th>
<th>AGE</th>
<th>Diameter (mm)</th>
<th>Length (cm)</th>
<th>Distance from lips to carina (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-6 mos</td>
<td>5</td>
<td>6</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>8 yo</td>
<td>8</td>
<td>8</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>14 yo &amp; older - Female</td>
<td>15</td>
<td>12</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>14 yo &amp; older – Male</td>
<td>20</td>
<td>14</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TUBE DIAMETER</th>
<th>Male adult</th>
<th>7.5/8.0 mm ETT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female adult</td>
<td>7.0/7.5 mm ETT</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>4+ (age/4)</td>
<td></td>
</tr>
<tr>
<td>TUBE DEPTH</td>
<td>Male adult</td>
<td>23 cm @ teeth</td>
</tr>
<tr>
<td></td>
<td>Female adult</td>
<td>21 cm @ teeth</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>12+ (age/2)</td>
</tr>
</tbody>
</table>

- Blow up the cuff: 4-5 cc of air is usually enough.
- Connect your ventilator circuit.
- Reach back and squeeze the manual ventilation bag to ventilate the patient. You may need to adjust the APL valve. Give 3 quick breaths.
- Check for mist in the tube. Look for bilateral chest rise. Look back at your capnography—you should see CO₂ breathing curves. The absence of these 3 suggests that you are not in the correct place (i.e. esophagus). If this happens, deflate the cuff, remove the ETT, mask ventilate for 4-5 breaths, and try again. In RSI, if correct placement is confirmed, cricoid pressure can be released.
- Listen for breath sounds: first right side then left. If the breath sounds on the left are diminished, slowly withdraw the ETT until breath sounds are equal bilaterally. Note the closest number on the tube in relation to the teeth.
- Start your mechanical ventilation by turning on the ventilation (Turn the BAG-APL/ Ventilator switch from Bag-APL to Ventilator.) Adjust gas flows and vaporizer concentration settings, minute/ tidal volume, and respiratory rate (IMV).
- Secure the ETT with thin pink tape and tape eyes closed if you have not done so already.

<table>
<thead>
<tr>
<th>VENTILATOR MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIDAL VOLUME: 6-8 cc/kg (depending on lung compliance) for adults, 10cc/kg for pediatrics</td>
</tr>
<tr>
<td>RESPIRATORY RATE (breaths/minute)</td>
</tr>
<tr>
<td>- Neonates &amp; infants: 20-30</td>
</tr>
<tr>
<td>- Children: 12-22</td>
</tr>
<tr>
<td>- Adults: 8-14</td>
</tr>
<tr>
<td>I:E RATIO:</td>
</tr>
<tr>
<td>- Healthy children &amp; Adults 1:2</td>
</tr>
<tr>
<td>- Mild obstruction 1:2.5</td>
</tr>
<tr>
<td>- Severe asthma or COPD 1:2.5 to 1:3</td>
</tr>
<tr>
<td>- Restrictive lung disease 1:1.5</td>
</tr>
</tbody>
</table>
A. **LARYNGEAL MASK AIRWAYS:**

- When using an LMA, prepare the appropriate sized LMA and have another size available. Make sure you can inflate & deflate it; apply a small amount of lubricant on the posterior side; and either partially or completely deflate the device.
- When ready to place the LMA, pull the patient’s mandible & tongue anteriorly, or use a scissoring technique to open the mouth adequately. As you slide it gently towards the center, apply pressure posteriorly against the palate to help guide it into the posterior pharynx until it “seats.”
- Confirm placement and ensure that you can deliver an adequate tidal volume with minimal leak.
- Keep in mind that an advantage of using an LMA is the patient can breathe spontaneously if desired by the provider. If you need to, however, you may place the patient on the ventilator using a pressure not to exceed the LMA’s ability to maintain a seal (typically this is 20cmH20 in classic LMAs, 30cmH20 in Proseal LMAs)
- LMAs do NOT protect against aspiration, so the device should always remain visible to the provider to assess for gastric regurgitation (i.e.: not under the drape where it is not visible)
- There is no “time limit” that an LMA can or cannot be used for. A danger arises when the LMA is placing too much pressure on the pharyngeal mucosa and limiting the blood flow to the tissues – this can cause tissue necrosis. As long as an adequate leak is present (usually around 20-25cmH20), this should indicate that excessive pressure is not being transmitted to the mucosa. During prolonged cases, air should be removed from the LMA to maintain a leak at 20-25cmH20.

<table>
<thead>
<tr>
<th>CLASSIC LMA</th>
<th>Patient Size</th>
<th>Maximum Cuff Volume (Air)</th>
<th>Largest ETT Internal Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neonates &amp; infants up to 5 kg</td>
<td>4 cc</td>
<td>3.5 mm</td>
</tr>
<tr>
<td>1.5</td>
<td>Infants 5-10 kg</td>
<td>7 cc</td>
<td>4.0 mm</td>
</tr>
<tr>
<td>2</td>
<td>Infants &amp; children 10-20 kg</td>
<td>10 cc</td>
<td>4.5 mm</td>
</tr>
<tr>
<td>2.5</td>
<td>Children 20-30 kg</td>
<td>14 cc</td>
<td>5.0 mm</td>
</tr>
<tr>
<td>3</td>
<td>Children &amp; adults 30-50 kg</td>
<td>20 cc</td>
<td>6.0 mm (cuffed)</td>
</tr>
<tr>
<td>4</td>
<td>Normal &amp; large adults 50-70 kg</td>
<td>30 cc</td>
<td>6.0 mm (cuffed)</td>
</tr>
<tr>
<td>5</td>
<td>Large adults 70-100 kg</td>
<td>40 cc</td>
<td>7.0 mm (cuffed)</td>
</tr>
<tr>
<td>6</td>
<td>Large adults over 100 kg</td>
<td>50 cc</td>
<td>7.0 mm (cuffed)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRO-SEAL LMA</th>
<th>Patient Size</th>
<th>Maximum Cuff Volume (Air)</th>
<th>Largest Gastric Drain Tube Size</th>
<th>Largest ETT Internal Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Adults 50-70 kg</td>
<td>30 cc</td>
<td>16 French</td>
<td>5.0 mm</td>
</tr>
<tr>
<td>5</td>
<td>Adults 70-100 kg</td>
<td>40 cc</td>
<td>18 French</td>
<td>6.0 mm (cuffed)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LMA-FASTRACH (intubating LMA)</th>
<th>Patient Size</th>
<th>Maximum Cuff Volume (Air)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Children &amp; adults 30-50 kg</td>
<td>20 cc</td>
</tr>
<tr>
<td>4</td>
<td>Adults 50-70 kg</td>
<td>30 cc</td>
</tr>
<tr>
<td>5</td>
<td>Adults 70-100 kg</td>
<td>40 cc</td>
</tr>
</tbody>
</table>

| LMA-FASTRACH ENDOTRACHEAL TUBE SIZES | 7.0 mm | 7.5 mm | 8.0 mm |
## CONTRAINDICATIONS FOR USING LMA’S

<table>
<thead>
<tr>
<th>Contraindications</th>
<th>Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients at risk for aspiration (GERD, pregnancy, full stomach/not NPO &gt;8 hours, acute trauma, presence of hiatal hernia, small bowel obstruction, etc.)</td>
<td>Patients who are not fully unconscious (may resist LMA placement or aspirate)</td>
</tr>
<tr>
<td>Patients with decreased pulmonary compliance (obesity, restrictive lung disease, etc.)</td>
<td>Pregnancy</td>
</tr>
<tr>
<td></td>
<td>Hiatal hernia, gastritis, peptic ulcer disease</td>
</tr>
<tr>
<td></td>
<td>Trauma patient</td>
</tr>
<tr>
<td></td>
<td>Any condition causing gastroparesis (uncontrolled diabetes, significant opioid administration, pregnancy, etc.)</td>
</tr>
<tr>
<td></td>
<td>Pharyngeal pathology or obstruction</td>
</tr>
</tbody>
</table>
A. FLUID MANAGEMENT:

1. MAINTENANCE FLUID: “4-2-1 cc/kg/hour”
   - For a 70 kg patient:
     - 4 x 1st 10 kg = 40 cc
     - 2 x 2nd 10 kg = 20 cc
     - 1 x remaining kg (50 kg) = 50 cc
     - Total = 110 cc/hour
   - SHORTCUT: If pt. is >20kg; Add 40 to patient’s wt in kg \( \Rightarrow 70 + 40 = 110 \text{ cc/hour} \)

2. ESTIMATED DEFICIT: “maintenance x # of hours of NPO status”
   - Replace ½ in the 1st hour of surgery
   - Replace next ¼ in the 2nd hour of surgery
   - Replace last ¼ in the 3rd hour of surgery

3. INSENSIBLE LOSS:
   - Minimal surgical exposure: 3-4 cc/kg/hour
   - Moderate surgical exposure: 5-6 cc/kg/hour
   - Maximum surgical exposure: 7-10 cc/kg/hour

4. ESTIMATE BLOOD LOSS (EBL):
   - 1 saturated lap = 80-100 cc
   - 1 saturated 4x4 = 10-20 cc
   - Check suction canister minus irrigation
   - Check surgical field and floor

5. ESTIMATED ALLOWABLE BLOOD LOSS:
   \[ \text{EBV} \times (\text{pt’s starting Hgb}) - (\text{pt’s allowable Hgb}) = \text{cc} \]

6. ESTIMATED BLOOD VOLUME:

<table>
<thead>
<tr>
<th>Age</th>
<th>Blood Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult male</td>
<td>75 cc/kg</td>
</tr>
<tr>
<td>Adult female</td>
<td>65 cc/kg</td>
</tr>
<tr>
<td>Child</td>
<td>80 cc/kg</td>
</tr>
<tr>
<td>Infant</td>
<td>80-85 cc/kg</td>
</tr>
<tr>
<td>Full-term</td>
<td>85-90 cc/kg</td>
</tr>
<tr>
<td>Pre-term</td>
<td>95-100 cc/kg</td>
</tr>
</tbody>
</table>

7. ALLOWABLE Hgb:

<table>
<thead>
<tr>
<th></th>
<th>Blood Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy patient</td>
<td>7-8</td>
</tr>
<tr>
<td>Elderly patient or patient with cardiac or pulmonary disease</td>
<td>10</td>
</tr>
</tbody>
</table>

8. REPLACEMENT:
   - 3:1 crystalloids (NS, LR)
   - 1:1 colloids (hespan, hextend, hetastarch, voluven, PRBCs, albumin)
Hypothermia is defined as a body temperature of less than 36 degrees Celsius. During times of cerebral or cardiac ischemia, hypothermia is acceptable because it decreases the metabolic \( O_2 \) requirement of the tissues. The problems associated with hypothermia include the following:

- Cardiac dysrhythmias
- Increase in peripheral vascular resistance
- Left shift of Hgb-\( O_2 \) saturation curve
- Reversible coagulopathy (platelet dysfunction)
- Post-op protein catabolism stress response
- Altered mental status
- Impaired renal function
- Decrease in drug metabolism
- Poor wound healing
- Post-op shivering increases \( O_2 \) consumption \( \rightarrow \) decreases \( PaO_2 \) \( \rightarrow \) increases risk of myocardial ischemia and angina

There are 3 phases of change in a patient’s core body temperature:

- **PHASE I**: decrease of 1 or 2 degrees Celsius during the 1st hour of GA
  - Secondary to the redistribution of heat from central compartments (abdomen, thorax) to cooler peripheral tissues (arms, legs) from anesthetic-induced vasodilation
- **PHASE II**: gradual decline in temperature during the next 3-4 hours of GA
  - Secondary to heat loss to the environment
- **PHASE III**: steady state or equilibrium where heat loss equals metabolic heat production

GA inhibits the hypothalamus in regulating core body temperature (via sweating & vasodilation or shivering & vasoconstriction). During regional anesthesia, Phase I occurs because the hypothalamus triggers vasodilation and internal redistribution of heat. Phase II occurs because of the patient’s altered perception of temperature in the blocked dermatomes.

The incidence of unintentional perioperative hypothermia increases with:

1. extremes of age
2. abdominal surgery
3. surgery of long duration
4. cold environment/OR

**Patients must have a temperature greater than 36° Celsius prior to leaving the OR.**
BASIC PHARMACOLOGY FOR ANESTHESIA

This information is to be used as a high-yield reference only. All information should be verified and confirmed by outside sources.

**Students should read additional chapters 9-17 in Morgan & Mikhail’s Clinical Anesthesiology 5th edition to supplement the information below**

All drugs must be labeled with your initials, date, and concentration.

**TERMINOLOGY:**

1. **AGONIST** – substance that activates receptors
2. **ANTAGONIST** – substance that binds to receptors but does not activate them
   - a. competitive
   - b. noncompetitive
3. **ADDITIVE** – refers to the addition of a second drug which has a predictable effect equal to summation (i.e. 1 MAC + 1 MAC = 2 MAC)
4. **SYNERGY** – refers to a second drug producing an effect greater than the summation of both drugs (i.e. aminoglycosides have little effect in muscle relaxation alone, but when combined with nondepolarizing relaxants, their effect can be substantial)
5. **CROSS TOLERANCE** – development of reduced effects of drugs of different classes but similar pharmacologic effects

**A. INDUCTION AGENTS:**

<table>
<thead>
<tr>
<th>AGENT (IV induction dose)</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SODIUM THIOPENTAL (STP) 3-6 mg/kg</td>
<td>-reliable -little pain on injection -economical</td>
<td>-direct CV depression and vasodilation</td>
<td>-rapidly redistributed, but has a long half-life so it may contribute to post-op sedation</td>
</tr>
<tr>
<td>PROPOFOL 1-2 mg/kg</td>
<td>-rapidly cleared -minimal post-op sedation -causes less PONV than other induction agents -also used for IV sedation and has amnestic properties</td>
<td>-CV depression -pain on injection -relatively expensive</td>
<td>-contraindicated in patient with allergy to eggs or soybean oil</td>
</tr>
<tr>
<td>ETOMIDATE 0.2-0.6 mg/kg</td>
<td>-DRUG OF CHOICE to avoid CV depression</td>
<td>-stings on injection -myoclonus and adrenal suppression have been seen after administration</td>
<td></td>
</tr>
<tr>
<td>KETAMINE 1-2 mg/kg</td>
<td>-only IM induction agent available -can be given IV at smaller doses -causes sympathetic activation, often increasing BP and HR → helpful for the asthmatic and hypovolemic patients</td>
<td>-contraindicated in closed head injury -emergence delirium may occur as high as 30% of adult patients (not frequently used in adults) -increases ICP and IOP -increases airway secretions</td>
<td>-used in kids (no emergence delirium)</td>
</tr>
<tr>
<td>BENZODIAZEPINE Midazolam (Versed) 0.15-0.35 mg/kg</td>
<td>-can be used as an induction agent in high doses, but more often as an adjuvant -uses include: preop sedation (anxiolysis and anterograde amnesia), IV sedation, and suppression of seizure activity</td>
<td>-used in combination with opioids, CV depression may be seen</td>
<td>-because of its short half-life, midazolam (versed) is mainly used in anesthesia -flumazenil is used to rapidly reverse overdose</td>
</tr>
</tbody>
</table>
OPIOIDS
- can be used as an induction agent, although more often used as an adjuvant
- good CV stability with analgesia
- help attenuate sympathetic responses to noxious stimuli
- causes dose dependent ventilatory depression while maintaining adequate tidal volumes
- not particularly helpful in treating HTN
- do not reliably cause unconsciousness
- causes dose dependent ventilatory depression
- naloxone is used in overdose

AGENTS we typically use for our cases:
- Alfentanil (ultra short)
- Fentanyl (short)
- Morphine (long)
- Fentanyl & Morphine: cause vagus-mediated bradycardia; decrease dose in renally impaired patients

B. MUSCLE RELAXANTS:
These are categorized into depolarizing and nondepolarizing.

**Depolarizing agent:**
- Causes a massive release in acetylcholine (Ach) and for a short period of time, Ach is not available for muscle contractions
- Cannot be reversed by cholinesterase inhibitors

**Nondepolarizing agent:**
- Acts as a competitive inhibitor at the neuromuscular junction
- Can be reversed by cholinesterase inhibitors

<table>
<thead>
<tr>
<th>AGENT (IV intubating dose)</th>
<th>ONSET &amp; RECOVERY</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
</table>
| Succinylcholine DEPOLARIZING | Onset: 15-30 seconds Recovery: 5 minutes | -Reliable & profound relaxation | -Myalgias
-Transient increases in potassium
-Associated with malignant hyperthermia
-Occasional prolonged blockade due to pseudocholinesterase deficiency |
| Pancuronium 0.08 – 0.12 mg/kg | Onset: 2-3 minutes Recovery: 1 hour (long-acting, inexpensive) | -Long duration precludes its use in most cases
-Causes a mild tachycardia |
| Rocuronium 0.45 – 1 mg/kg | Onset: 2 minutes Recovery: 20 minutes (intermediate duration) | -Can precipitate when mixed with sodium thiopental |
| Atracurium 0.3 – 0.6 mg/kg | Onset: 2-3 minutes Recovery: 30 minutes (intermediate duration) | -Predictable elimination even in patients with renal and hepatic failure
-May cause histamine release in high doses |
| Mivacurium OFF MARKET 0.15 – 0.25 mg/kg | Onset: 2-3 minutes Recovery: 10-20 minutes (shortest-acting nondepolarizer) | -Can occasionally be prolonged due to pseudocholinesterase deficiency
-If reversed, may lead to prolonged duration of action |
| Cisatracurium 0.15 – 0.2 mg/kg | Onset: 2 minutes Recovery: 30 minutes | -Hofmann degradation, therefore metabolism & elimination independent of renal or liver failure |
| Vecuronium 0.08 – 0.2 mg/kg | Onset: 2-3 minutes Recovery: 45 minutes | -Can precipitate when mixed with sodium thiopental |
C. ANTAGONISM OF MUSCLE RELAXANTS:
In general, the effects of neostigmine appear 5-10 minutes after administration.

| GLYCOPYRROLATE | • Anti-cholinergic agent that blocks muscarinic receptors  
|                | • Prevents a vagal response when neostigmine is given  
| 0.01 – 0.02 mg/kg IV | • Increases HR (should be given before neostigmine is given) |

| NEOSTIGMINE | • Antagonizes nondepolarizing blockade by increasing the amount of Ach at the motor end plate by 2 mechanisms:  
|             |   o Inhibition of acetylcholinesterase  
| 0.04 – 0.08 mg/kg IV |   o Increased release of ACh at the motor nerve ending  
|                  | • Decreases HR  
|                  | • CAUTION: can cause asystole |
D. INHALATIONAL ANESTHETICS:

**Students should read Morgan/Mikhail Chapter 8 to supplement the information in this packet regarding inhalational anesthetics – information below is NOT ENOUGH to master an understanding of inhalational anesthetics**

Modern inhalational anesthetics are derivatives of methyl ethyl ether that have chlorine or fluorine substitutions. Halothane, enflurane, isoflurane, desflurane, and sevoflurane are common modern volatile anesthetics. All inhalational agents produce dose dependent effects on the CV and ventilatory systems. These effects are drug specific...in general, volatile agents depress the CV system causing BP, CO, and myocardial contractility to decrease. They also increase RR while causing TV and response to CO₂ to decrease.

**CHARACTERISTICS OF AN IDEAL INHALED ANESTHETIC**

<table>
<thead>
<tr>
<th>Characteristics of an Ideal Inhaled Anesthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Absence of flammability</td>
</tr>
<tr>
<td>• Easily vaporized at ambient temperature</td>
</tr>
<tr>
<td>• Potent</td>
</tr>
<tr>
<td>• Low blood solubility</td>
</tr>
<tr>
<td>• Minimal metabolism</td>
</tr>
<tr>
<td>• Cardiovascular stability</td>
</tr>
<tr>
<td>• Skeletal muscle relaxation</td>
</tr>
<tr>
<td>• Non-irritating / bronchodilation</td>
</tr>
<tr>
<td>• Suppression of excessive sympathetic nervous system activity</td>
</tr>
<tr>
<td>• Absence of cerebral vasodilation</td>
</tr>
</tbody>
</table>

The primary objective is maintaining a constant and optimal partial pressure of the anesthetic in the brain. Alveolar partial pressure is related to arterial partial pressure, which is related to brain partial pressure.

**FACTORS THAT DETERMINE THE ALVEOLAR PARTIAL PRESSURE**

<table>
<thead>
<tr>
<th>Input</th>
<th>1. Partial pressure of the inspired gas – concentration effect, second gas effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Alveolar ventilation – promotes input of inhaled anesthetic to offset uptake into the blood</td>
</tr>
<tr>
<td></td>
<td>3. Characteristics of the anesthetic breathing system – volume of anesthetic system buffers changes in anesthetic concentration and the gas inflow helps negate that buffer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Uptake</th>
<th>1. Solubility – more soluble substances are uptaken through the blood decreasing alveolar partial pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Cardiac output – high CO increases uptake as well, decreasing induction of anesthesia</td>
</tr>
<tr>
<td></td>
<td>3. Alveolar to venous partial pressure – the difference in pressure represents tissue uptake of the inhaled anesthetic; equilibration occurs after 3-4 time constants (6-15 minutes), reflected in the narrowing of the alveolar to venous partial pressure</td>
</tr>
</tbody>
</table>

**MAC**= minimum alveolar concentration of inhaled gas @ 1 atm that prevents skeletal muscle movement in 50% of patients in response to surgical incision

1.5 MAC = MAC “bar” = MAC that blunts adrenergic response
1.3 MAC = MAC that prevents movements in 95% of patients
0.3-0.4 MAC = MAC “awake” = MAC that patients awaken from anesthesia

**FACTORS THAT AFFECT MAC**

<table>
<thead>
<tr>
<th>Increase MAC</th>
<th>Decrease MAC</th>
<th>No Effect on MAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperthermia</td>
<td>Hypothermia</td>
<td>Duration of anesthesia</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Acute ETOH intoxication</td>
<td>Hyper- or hypo- kalemia</td>
</tr>
<tr>
<td>Chronic ETOH abuse</td>
<td>Pregnancy</td>
<td>Thyroid gland dysfunction</td>
</tr>
<tr>
<td>Acute cocaine ingestion</td>
<td>Postpartum (returns to normal in 24 – 72 hours)</td>
<td>Gender</td>
</tr>
<tr>
<td>Acute amphetamine ingestion</td>
<td>Chronic amphetamine ingestion</td>
<td>PaCO₂: 15-95 mmHg</td>
</tr>
<tr>
<td>MAO-inhibitors</td>
<td>Clonidine</td>
<td>PaO₂ &gt; 38 mmHg</td>
</tr>
<tr>
<td>TCAs</td>
<td>Lithium</td>
<td>MAP &gt; 40 mmHg</td>
</tr>
<tr>
<td>Infants</td>
<td>Elderly</td>
<td>Spinal cord transection</td>
</tr>
<tr>
<td></td>
<td>Neonates</td>
<td>Guanethidine (depletes peripheral CA stores, central stores still intact)</td>
</tr>
<tr>
<td></td>
<td>Cardiopulmonary bypass</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAP &lt; 40 mmHg</td>
<td></td>
</tr>
</tbody>
</table>
**PaO₂ < 38 mmHg**

- Pre-op medication
- IV anesthetics

### RECOVERY FROM ANESTHESIA

<table>
<thead>
<tr>
<th>TISSUE CONCENTRATION</th>
<th>• Tissue concentrations of inhaled anesthetics act as a reservoir to slow emergence</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIFFUSION HYPOXIA</td>
<td>• Essentially second gas effect in reverse</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AGENT</th>
<th>MAC</th>
<th>Solubility</th>
<th>SYSTEM EFFECTS</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NITROUS OXIDE</td>
<td>105</td>
<td>-Low</td>
<td>-Minimal CV depression&lt;br&gt;-Activates sympathetic NS (small increase in CO and arterial BP) via increase in endogenous CA levels</td>
<td>-Low solubility→ fast induction &amp; emergence&lt;br&gt;-Good analgesic</td>
<td>-High MAC (not used as sole agent)&lt;br&gt;-Expansion of closed spaces (bowel &amp; PTX)</td>
</tr>
<tr>
<td>HALOTHANE</td>
<td>0.75</td>
<td>-High</td>
<td>-CV depression via decreasing myocardial contractility &amp; minimal decrease in SVR&lt;br&gt;-Cerebral vasodilation...increases CBF &amp; ICP</td>
<td>-Sweet odor→ good for mask induction (CHILDREN)</td>
<td>-Can induce arrhythmias in the presence of catecholamine&lt;br&gt;-Halothane hepatitis&lt;br&gt;-High solubility (slow emergence)</td>
</tr>
<tr>
<td>ISOFLURANE</td>
<td>1.2</td>
<td>-b/w nitrous &amp; halothane</td>
<td>-CV depression via myocardial depression &amp; moderate decrease in SVR&lt;br&gt;-Increases in HR may be seen&lt;br&gt;-Dilates coronary aa.&lt;br&gt;-Decreases cerebral vascular resistance...increases CBF &amp; ICP but less than other gases</td>
<td>-Because CO is maintained well (gold standard for longer cases&lt;br&gt;-Neurosurgery</td>
<td>-Pungent odor&lt;br&gt;-Coronary steal</td>
</tr>
<tr>
<td>DESFLURANE</td>
<td>6.0</td>
<td>-Low (almost as good as nitrous)</td>
<td>-Although contractility is minimally affected, a pronounced drop in SVR occurs&lt;br&gt;-HR increases especially when first using this agent&lt;br&gt;-Decreases cerebral vascular resistance...increases CBF &amp; ICP</td>
<td>-Strong odor&lt;br&gt;-May cause airway irritation on emergence (i.e.- laryngospasm)&lt;br&gt;-May cause CO poisoning with high fresh gas flows</td>
<td></td>
</tr>
<tr>
<td>SEVOFLURANE</td>
<td>2.0</td>
<td>-Low (behind nitrous &amp; desflurane)</td>
<td>-CV profile is similar to isoflurane&lt;br&gt;-Mild increase in CBF &amp; ICP</td>
<td>-Mild smell (well tolerated in mask induction)</td>
<td>-Because of potential interactions with soda-lime canisters, do not decrease fresh gas flows below 2L/min&lt;br&gt;-Prevent build up of COMPOUND A, use at least 2L/min of fresh gas flow (i.e renal tubular necrosis)</td>
</tr>
</tbody>
</table>

**Note:** Desflurane and sevoflurane are much more expensive to use than isoflurane. Try to restrict usage of these two agents to short cases or outpatient procedures.
E. ANITBIOTICS

<table>
<thead>
<tr>
<th>ANTIBIOTIC</th>
<th>ADULTS</th>
<th>CHILDREN</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEFAZOLIN (Ancef)</td>
<td>1-2 g/dose</td>
<td>25 mg/kg/dose</td>
<td></td>
</tr>
<tr>
<td>CEFOTETAN</td>
<td>1-2 g/dose</td>
<td>20-40 mg/kg/dose</td>
<td></td>
</tr>
<tr>
<td>AMPICILLIN</td>
<td>0.5-3g/dose</td>
<td>50-100 mg/kg/dose</td>
<td></td>
</tr>
<tr>
<td>CLINDAMYCIN</td>
<td>600 mg/dose</td>
<td>5-10 mg/kg/dose</td>
<td>NO IV PUSH; Run over 30 minutes or will cause hypotension</td>
</tr>
<tr>
<td>GENTAMICIN</td>
<td>1-2.5 mg/kg/dose</td>
<td>2.5 mg/kg/dose for &lt;5 years old; 2 mg/kg/dose for &gt;5 years old</td>
<td>NO IV PUSH; Run over 30 minutes to prevent nephrotoxicity and ototoxicity; adjust dose in renal impairment</td>
</tr>
<tr>
<td>VANCOMYCIN</td>
<td>0.5-1 g/dose</td>
<td>10-15 mg/kg/dose</td>
<td>NO IV PUSH; Run over 1 hour to prevent vasodilation; adjust dose in renal impairment</td>
</tr>
</tbody>
</table>

H. LOCAL ANESTHETICS

A. TOXICITY:

Local anesthetics can produce undesirable effects if given in toxic doses or injected into the vasculature. Signs and symptoms of CNS toxicity include:

- Tinnitus
- Metallic taste
- Visual disturbances
- Numbness of tongue or lips
- Muscle twitching
- LOC, seizure, coma

TREATMENT: O₂ & anticonvulsant therapy (Versed 1-2 mg or STP 50-150 mg) or propofol in pregnant patients. Intralipid for treatment of cardiac effects (block).

B. MAXIMUM DOSES:

<table>
<thead>
<tr>
<th>DRUG</th>
<th>MAXIMUM DOSE – PLAIN</th>
<th>MAXIMUM DOSE – with EPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>4.5 mg/kg</td>
<td>7 mg/kg</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>2.5 mg/kg</td>
<td>3 mg/kg</td>
</tr>
<tr>
<td>Ropivacaine</td>
<td>2.5 mg/kg</td>
<td>3 mg/kg</td>
</tr>
<tr>
<td>Procaine</td>
<td>8 mg/kg</td>
<td>14 mg/kg</td>
</tr>
<tr>
<td>Chloroprocaine</td>
<td>11 mg/kg</td>
<td>14 mg/kg</td>
</tr>
<tr>
<td>Tetracaine</td>
<td>1 mg/kg</td>
<td>2.5 mg/kg</td>
</tr>
<tr>
<td>Cocaine (topical)</td>
<td>3 mg/kg</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Convert the percentage of local anesthetic to mg/kg:

Example: 1% Lidocaine, patient is 70 kg → what is the max dose for local injection?
MECHANICAL VENTILATION

Continuous Mandatory Ventilation (Volume or Pressure Control)

CMV is present when the ventilator is programmed to deliver a set tidal volume or pressure at a set respiratory rate, which allows the delivery of predictable minute ventilation. Regardless of the patient’s effort, the ventilator will deliver its pre-set tidal volume or pressure at its pre-set time. If the patient makes additional efforts between delivered breaths, these breaths will not be supported.

Synchronized Intermittent Mandatory Ventilation (SIMV)

Ventilator allows clinicians to set tidal volume and deliver at a set rate. However, additional breaths are detected by the ventilator and supported with additional pressure support. The ventilator attempts to synchronize to mandatory breaths with these patient-initiated breaths. However, the ventilator will maintain the desired minimum ventilation set by the clinician regardless of patient initiation of additional breaths.

Pressure Support Ventilation (PSVpro)

The ventilator does not deliver a pre-set tidal volume but instead relies on the patient’s intrinsic respiratory drive. When the machine senses the patient initiating a breath, the ventilator delivers a pre-set positive pressure to assist the patient in obtaining an adequate minute ventilation. If the patient does not initiate a breath, the ventilator will not deliver anything. However, there is a backup mode feature that will activate if the patient is apneic for a certain period of time (usually 30 seconds). This back up mode is generally a pressure control mode that will resume mandatory ventilation.

- 1% Plain Lidocaine=10mg/mL
  - Move the decimal point to the right once to convert percentage to mg.
- Toxic dose is (4.5 mg/kg) x 70kg = 315 mg.
- Multiply by vial concentration:
  - (315 mg) x (1ml/10mg) = 31.5 mL
  - Therefore the max dose that can be injected is 31.5 mL or cc
**Medical students should read Morgan/Mikhail 5th edition chapter 45 FIRST to understand this material, and then use below as additional information**

<table>
<thead>
<tr>
<th>LOCAL ANESTHETICS FOR EPIDURAL &amp; CAUDAL ANESTHESIA</th>
<th>ANESTHETIC</th>
<th>CONCENTRATION (%)</th>
<th>DURATION (HR)</th>
<th>DURATION (HR) with epi</th>
<th>DOSE RANGE (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorprocaine</td>
<td>2-3</td>
<td>0.25-0.5</td>
<td>0.5-1</td>
<td>-</td>
<td>20-30</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>1-2</td>
<td>0.5-1.0</td>
<td>-.75-1.5</td>
<td>-</td>
<td>20-30</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>1-2</td>
<td>0.75-1.0</td>
<td>1-2</td>
<td>-</td>
<td>20-30</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>0.25-0.75</td>
<td>1.5-3.0</td>
<td>2-4</td>
<td>-</td>
<td>20-30</td>
</tr>
<tr>
<td>Ropivacaine</td>
<td>0.5-1.0</td>
<td>2-6</td>
<td>--</td>
<td>-</td>
<td>15-30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOCAL ANESTHETICS USED FOR SURGICAL EPIDURAL BLOCK</th>
<th>DRUG</th>
<th>2-Dermatome Regression (min)</th>
<th>Complete Resolution (min)</th>
<th>% Epinephrine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorprocaine 3%</td>
<td>45-60</td>
<td>100-160</td>
<td>40-80</td>
<td></td>
</tr>
<tr>
<td>Lidocaine 2%</td>
<td>60-100</td>
<td>160-200</td>
<td>40-80</td>
<td></td>
</tr>
<tr>
<td>Mepivacaine 2%</td>
<td>60-100</td>
<td>160-200</td>
<td>40-80</td>
<td></td>
</tr>
<tr>
<td>Ropivacaine 0.5-1.0%</td>
<td>90-180</td>
<td>240-420</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Etidocaine 1-1.5%</td>
<td>120-240</td>
<td>300-460</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Bupivacaine 0.5-0.75%</td>
<td>120-240</td>
<td>300-460</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DURATION OF SENSORY BLOCK IN SPINAL ANESTHESIA</th>
<th>DRUG</th>
<th>DOSE (mg)</th>
<th>2-Dermatome Regression (min)</th>
<th>Complete Resolution (min)</th>
<th>Prolongation by Adrenergic Agonist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procaine</td>
<td>50-200</td>
<td>30-50</td>
<td>90-120</td>
<td>30-50</td>
<td></td>
</tr>
<tr>
<td>Lidocaine</td>
<td>25-100</td>
<td>40-100</td>
<td>140-240</td>
<td>20-50</td>
<td></td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>5-20</td>
<td>90-140</td>
<td>240-380</td>
<td>20-50</td>
<td></td>
</tr>
<tr>
<td>Tetracaine</td>
<td>5-20</td>
<td>90-140</td>
<td>240-380</td>
<td>50-100</td>
<td></td>
</tr>
</tbody>
</table>

(1) Duration is influenced by dose and block height.  
(2) The lowest doses are used primarily for very restricted blocks (i.e. Saddle block), unless they become too dilute to be effective  
(3) The effect of adrenergic agonists depends on the dose and choice of agonist. Prolongation is greatest at the lumbar and sacral dermatomes and least at the thoracic dermatomes

<table>
<thead>
<tr>
<th>SUGGESTED MINIMUM CUTANEOUS LEVELS FOR SPINAL/EPI DURAL ANESTHESIA</th>
<th>OPERATIVE SITE</th>
<th>LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower extremities</td>
<td>T12</td>
<td></td>
</tr>
<tr>
<td>Hip</td>
<td>T10</td>
<td></td>
</tr>
<tr>
<td>Vagina, uterus</td>
<td>T10</td>
<td></td>
</tr>
<tr>
<td>Bladder, prostate</td>
<td>T10</td>
<td></td>
</tr>
<tr>
<td>Lower extremities with tourniquet</td>
<td>T8</td>
<td></td>
</tr>
<tr>
<td>Testes, ovaries</td>
<td>T8</td>
<td></td>
</tr>
<tr>
<td>Lower intraabdominal</td>
<td>T6</td>
<td></td>
</tr>
<tr>
<td>Other intraabdominal</td>
<td>T4</td>
<td></td>
</tr>
</tbody>
</table>
**BASIC COMPLICATIONS OF SPINAL ANESTHETICS**

- Hypotension
- Bradycardia, asystole, cardiac arrest
- Postspinal headache secondary to dural puncture
- Inadequate duration of block
- Patchy block or no block
- Total spinal (high/complete)
- Nausea
- Urinary retention/ bowel incontinence
- Backache
- Transient radicular irritation
- Hypoventilation
- Nerve damage, loss of sensation, motor weakness (not necessarily due to the spinal but more likely due to positioning)

**BASIC COMPLICATIONS OF EPIDURAL ANESTHETICS**

- Same as spinal, plus:
- Dural puncture/ headache
- Intrathecal injection
- Subdural injection
- Intravascular injection
- Epidural hematoma

**BARIETY OF SOLUTIONS COMMONLY USED FOR SPINAL ANESTHESIA**

<table>
<thead>
<tr>
<th>HYPERBARIC</th>
<th>BARIETY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(measured at 37 degrees Celsius)</td>
</tr>
<tr>
<td>Tetracaine 0.5% in 5% dextrose</td>
<td>1.0133</td>
</tr>
<tr>
<td>Bupivacaine 0.75% in 8.25% dextrose</td>
<td>1.0227</td>
</tr>
<tr>
<td>Lidocaine 5% in 7.5% dextrose</td>
<td>1.0265</td>
</tr>
<tr>
<td>Procaine 10% in water</td>
<td>1.0104</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ISOBARIC</th>
<th>BARIETY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(measured at 25 degrees Celsius)</td>
</tr>
<tr>
<td>Tetracaine 0.5% in NS or CSF</td>
<td>0.9997</td>
</tr>
<tr>
<td>Bupivacaine 0.75% in NS or CSF</td>
<td>0.9988</td>
</tr>
<tr>
<td>Bupivacaine 0.5% in NS or CSF</td>
<td>0.9983</td>
</tr>
<tr>
<td>Lidocaine 2% in saline</td>
<td>0.9986</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HYPOBARIC</th>
<th>BARIETY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(measured at 25 degrees Celsius)</td>
</tr>
<tr>
<td>Tetracaine 0.2% in water</td>
<td>0.9922</td>
</tr>
<tr>
<td>Bupivacaine 0.3% in water</td>
<td>0.9946</td>
</tr>
<tr>
<td>Lidocaine 0.5% in water</td>
<td>0.9985</td>
</tr>
</tbody>
</table>
EMERGENCY DRUGS:

<table>
<thead>
<tr>
<th>DRUG</th>
<th>ACTION</th>
<th>VIAL</th>
<th>PREPARATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHENYLEPHRINE</td>
<td>• Alpha-1-agonist &lt;double dilution&gt;</td>
<td>10 mg/mL</td>
<td>1. Draw 0.1 cc into a TB syringe, mix with 9.9 cc of NS in a 10 cc syringe -&gt; 100 mcg/mL **Usual dose is 100 mcg (1 mL), titrate to effect --OR-- 2. Add 1 cc to a 250 cc bag of NS or 5% Dextrose -&gt; 40 mcg/mL</td>
</tr>
<tr>
<td>EPHEDRINE</td>
<td>• Indirect sympathomimetic &lt;single dilution&gt;</td>
<td>50 mg/mL</td>
<td>Draw 1 cc into a 10 cc syringe, add 9 cc of NS -&gt; 5 mg/mL **Usual dose is 5 mg (1 mL), titrate to effect</td>
</tr>
<tr>
<td>SUCCINYLCHOLINE</td>
<td>• Muscle relaxant Slowly and reversibly binds Ach-R depolarizes at NMJ</td>
<td>200 mg/10 mL</td>
<td>Draw 5 cc straight into a 5 cc syringe -&gt; 20 mg/mL **Usual intubating dose is 0.3 – 1.1 mg/kg</td>
</tr>
<tr>
<td>ATROPINE</td>
<td>• Inhibits muscarinic-R in CNS &amp; parasympathetic effector sites</td>
<td>0.4 mg/mL</td>
<td>Draw 2 cc straight into a 3 cc syringe -&gt; 0.4 mg/mL **Usual dose is 0.01-0.02 mg/kg</td>
</tr>
</tbody>
</table>

**IV DRIPS**

When diluting IV medication into a 250 cc bag of fluid, the easiest way to calculate the final concentration is to multiply the drug (mg) by 4 to get the concentration in mcg/mL or mcg/cc.

**REASONING:** It takes 4 bags of 250 cc to make 1 liter. You know that (mg/L) = (mcg/mL). Multiply the drug (mg) x 4 to get the concentration in 1 liter. This gives you mg/L which equals mcg/mL or mcg/cc.

<table>
<thead>
<tr>
<th>DRUG</th>
<th>VIAL</th>
<th>CONCENTRATION AFTER ADDING TO 250 cc BAG OF NS</th>
<th>STARTING RATE OF INFUSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOPAMINE</td>
<td>400 mg in 5 mL</td>
<td>1600 mcg/mL</td>
<td>3-20 mcg/kg/min</td>
</tr>
<tr>
<td>DOBUTAMINE</td>
<td>500 mg in 1 mL</td>
<td>2000 mcg/mL</td>
<td>5-20 mcg/kg/min</td>
</tr>
<tr>
<td>EPINEPHRINE</td>
<td>1 mg in 1 mL</td>
<td>4 mcg/ml</td>
<td>2 mcg/min</td>
</tr>
<tr>
<td>NOREPINEPHRINE</td>
<td>4 mg in 1 mL</td>
<td>16 mcg/mL</td>
<td>1 mcg/min</td>
</tr>
<tr>
<td>(Levophed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHENYLEPHRINE</td>
<td>10 mg in 1 mL</td>
<td>40 mcg/mL</td>
<td>10 mcg/min</td>
</tr>
<tr>
<td>(Neosynephrine)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NITROPRUSSIDE</td>
<td>50 mg in 1 mL</td>
<td>200 mcg/mL</td>
<td>0.5 – 8 mcg/kg/min</td>
</tr>
<tr>
<td>NITROGLYCERIN</td>
<td>100 mg in 1 mL</td>
<td>400 mcg/mL</td>
<td>10-15 mcg/min</td>
</tr>
</tbody>
</table>
• I have read and the Medical Student Orientation Handbook for this academic year and I understand that it is my responsibility to read and comply with the policies contained in this handbook. The handbook describes important information about the rotation, and I understand that this handbook replaces any previous understanding, practice, manual, handbook or workplace addenda, policy or representation concerning the terms and conditions of the rotation.
• I agree to abide by the policies and procedures contained within the handbook and on the department website (rcrmc-ar.org). I understand that the policies and benefits contained in this handbook may be changed, modified, or deleted at any time.
• I understand that it is my responsibility to retain a copy of this handbook and to request a new copy if mine is lost or damage.

____________________________
Rotator Name (please print)

______________________________   ____________________
Rotator Signature            Date