Pharmacology Critical Thinking

- What you are doing?
- Why you are doing it?
- What will happen?
- What are you going to do about it?

Hemodynamics in Brief = 2 End Point

Cardiac output
- Amount of blood ejected from the ventricle in one minute
- $SV \times HR$
  - Normal: 4-8 L/min
  - $100 \text{ ml} \times 70 = 7000 \text{ ml/min} = 7 \text{ L/min}$
  - $SVO_2 = 60-80\%$
  - $25\%$

O2 Consumption

Compensatory heart rate

- Causes
  - Sympathetic:
  - Increased catecholamine
  - Dopamine
  - Epinephrine
  - Norepinephrine
- Increased metabolic demand
- Exercise
- Increase oxygen consumption
Noncompensatory Heart Rate

- Atrial Tach
- SVT
- Atrial Fibrillation
- Atrial Flutter
- VT

Non Compensatory Tachycardia

Hemodynamically Unstable
Low CO B/P

Cardiac System Regulators

Sympathetic Nervous System
- Speeds up-fight or flight

Parasympathetic Nervous System
- Slows down-rest and digest

Sympathetic Nervous System

- Beta-1 receptors
  - Located in the heart
  - Increase HR, contractility, and AV node conduction

- Beta-2 receptors
  - Located in blood vessels and lungs
  - Primary action is arteriolar and bronchial dilation

- Alpha receptors
  - Vascular smooth muscles
  - Vasconstriction of vascular beds responds to decreased volume

Parasympathetic Nervous System

- Vagus nerve
  - Slows heart rate and contractility

- Cholinergic
  - Acetylcholine (neurotransmitter)
  - Transmit nerve impulse to increase vagal tone

- Crystalloid compound released from nerve ending

Terms

- Inotropic
  - Affects contractility
  - A positive effect increases contractility
  - A negative effect decreases contractility

- Chronotropic
  - Affects the heart rate
  - A positive effect increases the heart rate
  - A negative effect decreases heart rate

- Dromotropic
  - Affects conductivity
  - AV node delay

Hemodynamics and Pharmacology
Titrate Pharmacology to Hemodynamic Parameters

Pharmacology → Hemodynamics

- HR
  - Tachy
  - Brady
  - Arrhythmias

- Preload
  - High
  - Low

- Afterload
  - High
  - Low

- Contractility
  - Squeeze

Pharmacology Principles

4 phases of Pharmacokinetics

- On-set
  - Absorption
    - Uptake in bloodstream
  - Distribution
    - To organs
    - Plasma protein binding
    - Blood flow
    - Tissue barriers

- Elimination
  - Elimination of drug from body
    - Renal
    - Liver

- Duration
  - Metabolism
    - Biotransformation of a drug into metabolites

Pharmacology Principles

Roles of drugs

- Agonist
  - Augment
  - Support

- Antagonist
  - Shuts down

Half Life

Time required for the body to reduce the amount of drug in the plasma by one half

Titrate to goal

- Know the Action
- Onset
- Duration

Titration Protocols

- Just inside normal range
  - ± 15 minutes

- Wait

- Monitor every hour

- Small incremental changes

- Know which parameter/s to assess

- Know HOW to titrate = (dosage change rate)
Pharmacology for Heart Rate

Medication for Tachycardia

SLOW THE HEART RATE
ADENOSINE
AMIODARONE
BETA BLOCKERS
CALCIUM CHANNEL BLOCKERS
LIDOCAINE

How do you assess /measure HR?

Tachycardia: Adenosine

Action Information
- Rapid IV bolus
  - Anti-arrhythmic properties
  - Slows cardiac conduction
  - AV node
  - Impending doom
  - Restores sinus rhythm
  - Any narrow complex tachycardia SVT
  - Adjunct in diagnosing Atrial flutter
- Cautions:
  - Bronchospasm

Administration
- Concentration: 3 mg/ml
- Dose range:
  - 6 mg IV push in large bore IV or central line
  - Repeat with 12 mg IV x 2, 1-2 minutes apart
- Onset: Immediate
- Duration: Seconds
- Monitoring Parameters:
  - Run strip during administration
  - HR, BP

Tachycardia: Amiodarone

Action Information
- AF/F, SVT
- Cautions:
  - Dedicated IV line
  - Use .2 micron filter
  - Initial hypotension
  - QT prolongation
  - Torsades
    - AV block
  - Negative inotrope
  - Peripheral site ok

Administration
- Concentration: 900 mg/500 mL = 1.8 mg/ml
- Dose range:
  - 150 mg IV over 10 minutes
  - 1mg/min (360 mg) for 6 hours
  - 0.5mg/min for 18 hrs (540 mg)
- Monitoring Parameters:
  - HR, B/P ([])
  - QT interval
- Long half life= 40-55 days
  - PFT in one week
  - LFT= AST &ALT
  - ↑ action of digoxin & warfarin
**Tachycardia: Amiodarone**

**Action information**
- VT, V-Fib arrest
- Prolongs duration of action potential in cardiac fibers
- Depresses conduction velocity
- Slows AV node conduction
- Some alpha and beta blockade activity
- May prevent recurrence

**Administration**
- Concentration
  - 150 mg/2 cc
  - Need 2 amp or vials
- Dose range
  - 300 mg IV push
  - May repeat 150 mg in 3-5 minutes
  - Start a drip

**Monitoring Parameters**
- HR rhythm
- QT

**Beta-Blockers for Tachycardia**

**Decrease HR**

**Decrease contractility**

**Dys-rhythmia**

**Decrease AV node conduction**

**Indication**
- Hypertension
- Post infarction management, angina

**Cautions**
- Hypotension
- Bradycardia
- Heart block
- CHF
- Bronchospasm
- Loss of compensatory balance

**Names:**
- Esmolol
- Atenolol
- Metoprolol
- Propanolol
  - Negative inotrope
  - Catecholamine drips

**Tachycardia: Esmolol**

**Action information**
- Uses:
  - Hypertension
  - Control SVT
  - A-tach

**Short acting**
- Beta 1 selective blocking agent
- Anti-arrhythmic effects (AV node)

**Administration**
- Concentration
  - 2500 mg/250 mL
  - 10 mg per cc
- Dose range
  - Load 500 mcg/kg/min for one minute
  - 50-300 mcg / kg / min
  - Repeat load

**Titration rate**
- 25-50 mcg/kg/min

**Monitoring Parameters**
- HR
- BP

**Calcium Channel Blockers for Tachycardia**

**Inhibit flux of calcium ions across cell membrane during phase 2 of action potential**

**Depress heart rate**
- Sinus node discharge
- Reduce conduction velocity through AV node

**Reduce vascular smooth muscle**
- Decreasing resistance
- Increase blood flow to coronary arteries
- Peripheral circulation

**Cautions:**
- Hypotension
- Brady arrhythmias
- Dizziness
- Headache
- Flushing

**Names:**
- Verapamil
- Diltiazem
- Nifedipine

**Tachycardia: Diltiazem**

**Action information**
- Inhibits influx of calcium
- Slows conduction through the AV node
- Reduces ventricular rate
- Good for AF with RVR

**Administration**
- Concentration
  - 100 mg/100 mL
  - 1 mg/ml
- Dose range
  - Load with 15-20 mg IV over 2 minutes
  - Followed by infusion of 5-20 mg/hr

**Titration rate**
- Titrated to goal heart rate
- Titrated by 5 mg per 15 minutes

**Monitoring Parameters**
- HR
- QT

**Tachycardia: Lidocaine**

**Action information**
- VT-tach and v-fib
- Increased PR and QRS
- Blurred vision, anxiety, confusion, euphoria

**Administration**
- Concentration
  - 2 gram/250cc
- Dose range
  - 1 mg/kg IV push (up to total of 3mg/kg)
  - Drip at 1-4 mg/min
  - Normal range 2-3 mg/min

**Titration rate**
- 1 mg at a time

**Monitoring Parameters**
- PVCs
Medication for Bradycardia

INCREASE THE HEART RATE
EPINEPHRINE
ATROPINE

Bradycardia: Atropine

Action information
- Reduces vagal tone
  - Inhibiting action of acetylcholine
  - Blocks parasympathetic response in smooth muscles
- Increase rate of sinus node
- Increases myocardial O2 demand and can trigger tachyarrhythmia
- Dilate the pupils
- Discharge and reduction in AV node refractoriness and conduction time

Administration
- Concentration: 1mg/10ml
- Dose range: 0.5-1mg IV every 3-5 minutes
- Do not give less than 0.5 mg IV= paradoxical bradycardia
- Not to exceed 0.04mg/kg (3 amps)
- Onset / Duration: Very rapid / 2-3 hours
- Titration rate: NA
- Monitoring Parameters: HR BP EKG

Bradycardia: Epinephrine

Action information
- Catecholamine sympathetic stimulus
- Vasoconstrictors
- Increased heart rate and blood pressure

Administration
- Concentration: 1mg/10cc
- Dose range: 1 mg every 3-5 minutes
- Titration rate: NA
- Monitoring Parameters: HR BP

Simulation: HR

Medication for Preload

How do you assess /measure Preload?
**Medication for High Preload**

**DECREASE PRELOAD**

- Lasix
- Bumex
- Nitroglycerine
- Morphine

**High Preload: Lasix**

**Action information**
- **Use:**
  - CHF, HTN, acute pulmonary edema
  - Acute or chronic renal failure.

**Diuretic acts on proximal and distal ends of the tubules and ascending limb of loop of Henley to excrete**
- Water
- Sodium
- Chlorides
- Potassium

**Administration**
- **Concentration:** 10mg/1cc
- **Dose range:**
  - Drip: 20-80 mg hour
  - Dose range: 20mg - 2 gm
  - Administer: 40mg over 1-2 minutes
- **Titrination rate:** 10-20 mg/hr
- **Monitoring Parameters:**
  - Potassium
  - U/O
  - Preload

**High Preload: Bumex**

**Action information**
- **Action:** same as lasix
  - Works in ascending loop of Henle
  - Excretes Na, K, Cl, H2O

- Bumex is chosen when lasix is at 100mg IV
  - The ratio is 1mg of bumex = to 40 mg of Lasix

**Administration**
- **Concentration:**
  - 1mg of bumex is 4cc (.25mg/cc)
- **Dose range:**
  - IVP Dose: 0.5 to 1mg may be repeated at 2-3 hour intervals (Not to exceed 10mg/24 h)
  - Give over 1-2 minutes
- **Titration rate:** 0.25-0.5 mg/hr
- **Monitoring parameters:**
  - RA, PAD, PAW
  - U/O, HR, Electrolytes

**Low Preload: Volume Replacement**

- **Crystalloids:**
  - Normal saline
  - Ringer’s lactate

- **Colloids:**
  - Dextran 40
  - Hetastarch (Hespan)
  - Albumin 25%
  - Albumin 5%
  - PRBCs

What determines whether colloid or crystalloid should be given?

**Low Preload: Hetastarch**

**Action information**
- **Hetastarch (Hespan):**
  - Expand plasma volume
  - 1ml / 1ml
  - Last 24-36 hours
  - Max dose 1500/24 hr

**Administration**
- **Dose range:**
  - 500-1000cc bolus
- **Titration rate:** NA
- **Monitoring Parameters:**
  - RA, U/O, CI
  - Lung sounds
  - Pits

**Caution**
- Fluid overload
- Decrease platelet >1500cc
**Low Preload: Albumin**

<table>
<thead>
<tr>
<th>Action information</th>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin 5%</td>
<td>Concentration</td>
</tr>
<tr>
<td></td>
<td>5% and 25%</td>
</tr>
<tr>
<td>Expanse plasma volume 1ml /1ml</td>
<td>Dose range</td>
</tr>
<tr>
<td></td>
<td>250-500ml bolus</td>
</tr>
<tr>
<td>Caution</td>
<td>Titration rate</td>
</tr>
<tr>
<td></td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Monitoring Parameters</td>
</tr>
<tr>
<td></td>
<td>B/P, preload, U/O, CO, HR</td>
</tr>
</tbody>
</table>

**Caution**
- Fluid overload
- Expensive and shortage supply

**Fluids or Vasoconstrictors?**
- Fill the tank before giving vasoactive medication.
- If hypotension persists with adequate fluid volume then vasoactive drugs should be initiated to improve tissue perfusions.

**Crystalloids**
- 80% of the volume is out of the vascular space within 20 min and promotes cellular edema.
- It takes a lot of crystalloids to increase preload.

**Colloids**
- Are held within the intravascular system significantly longer and exert pressure that helps maintain intravascular fluid.
- Less colloids are needed in comparison to crystalloid.
- Patients with increased capillary permeability, colloid will escape into the interstitial space exerting pressure in that area and produces edema.

**Fluid Balance Reserve: Hypovolemia to CHF**

**Normal heart**
- Healthy people, the difference in blood volume between Hypovolemic shock and heart failure may exceed 3-4 L.

**Diseased heart**
- Patients with preexisting cardiac disease may go from Hypovolemia to pulmonary edema with fluid infusion as little as 500-1000cc.

**Fluid Shift**
- Fluid overload may occur during initial resuscitation from shock.
- It is more likely to occur during fluid mobilization phase, which is usually 2-3 day after injury.

**How do you assess /measure Afterload?**
Medication for High Afterload

Decrease Afterload = Vasodilators
Nitroglycerine
Nipride
Flolan
Milrinone
Calcium channel blockers

Medication for Low Afterload

Increase Afterload = Vasoconstrictors
Norepinepherine
Phenylephrine
Epinepherine
Vasopressin
Dopamine

Afterload: Nitroglycerine

**Action information**
- Affects arterial and venous beds
- Decreases myocardial O2 demand
- Decreases preload and afterload
- Vasodilators
  - Nitroglycerine
  - Nipride
  - Flolan
  - Milrinone
- Calcium channel blockers

**Side Effects**
- Hypotension, Tachycardia, nausea and vomiting
- Headache
- Dizziness

**Alerts**
- Profound hypotension if given within 24 hours of Viagra
- With RV infarct

**Administration**
- Concentration
  - 50 mg/250 mL = 200 mcg/cc
  - 100 mg/250 mL = 400 mcg per cc
- Dose range
  - 20-200 mcg/min or Mcg/kg/min
- Onset/Duration
  - Immediate/3-5 minutes
- Titration rate
  - Start at 10-20 mcg/min and every 5 minutes
- Monitoring Parameters
  - Tolerance develops in patients over 12-72 hours
  - May require increase dosing
  - HR, MAP, IAP

Afterload: Nipride

**Action information**
- Potent rapid acting anti-HTN agent.
- Peripheral vasodilator, direct action on smooth muscle of the blood vessels.
- Metabolized in RBC to cyanide, then to liver to thiocyanate toxicity.
- Almost always given sodium thiosulfate.

**Uses**
- Anti-HTN, CHF, Cardiogenic shock.
- Protect from light.
- Liver and kidney dysfunction can affect metabolism and elimination.

**Alerts**
- Do not use in neurologic injury (trauma, stroke) will lead to increased ICP.

**Administration**
- Concentration
  - 50 mg/250 mL = 200mcgs/CC
- Dose range
  - Start at 0.25 mcg/kg/min
  - 0.5-10 mcg/kg/min (avg 3 mcg/kg/min)
  - Onset/Duration
  - <2min/1-10 minutes
- Titration rate
  - Increase by 2ng/kg/min Q 15 min
  - Do not stop longer than 2-3 minutes
- Monitoring Parameters
  - MAP, SVR = ↓
  - CO, HR = ↑
  - Renal & liver function

Afterload: Flolan****

**Action information**
- Use: P-HTN
- Both alpha and beta stimulation
- Peripheral vasodilation, direct action on smooth muscle of the blood vessels
- May be used in all hypertensive states
- Used in acute hypotensive states
- Peripheral IV

**Side Effects**
- Headache, Reflex Bradycardia, Arrhythmias
- Not compatible with any other medication

**Administration**
- Concentration
  - 8mg/500 ml DSW = 16 mcg/ml
- Dose range
  - 8-12 mcg/min load
  - 0.5-30mcg/min
- Onset/Duration
  - Very rapid/1-2 minutes
- Titration rate
  - 1-2mcg/min
- Monitoring Parameters
  - HR, HA, MAP, SVR, PAW
  - Renal output
  - Acidosis will diminish effects

Afterload: Norepinepherine Levophed

**Action information**
- Both alpha and beta stimulation
- Peripheral vasodilation
- Stimulates cardiac contractility
- Dilates coronary arteries

**Uses**
- Septic shock
- Preload should be normal or elevated before implementation

**Side Effects**
- Do not give with blood loss

**Administration**
- Concentration
  - 8mg/500 ml DSW =16 mcg/ml
- Dose range
  - 8-12 mcg/min load
  - 0.5-30mcg/min
- Onset/Duration
  - Very rapid/1-2 minutes
- Titration rate
  - 1-2mcg/min
- Monitoring Parameters
  - HR, HA, MAP, SVR, PAW
  - Renal output
  - Acidosis will diminish effects
**Afterload: Phenylephrine Neosynephrine**

**Action Information**
- Synthetic sympathomimetic acting
- Potent vasoconstrictor
- Use for hypotension
- Does not induce any change in HR
- Lack Chronotropic effect
  - Slows heart rate and increases stroke volume.
- End organ failure with prolong use.

**Administration**
- Concentration
  - 30mg/250ml = 120mcg/ml
- Dose range
  - Load: 100 – 180 mcg/minute
  - Then decrease to 40-60 mcg/kg once stabilized
- Onset/ Duration
- Titration rate
  - 10-20 mcg every 15 min
- Monitoring Parameters
  - HR, MAP, HA, arrhythmias

**Afterload: Epinephrine**

**Action Information**
- Natural and potent catecholamine
- Both alpha and beta agonist effect
  - Increases HR, BP, SVR
  - Increase cerebral and coronary blood flow.
  - Increase myocardial o2 demand
  - Increase contractility

**What for**
- Asystole, V-fib, Bradycardia, PEA

**Administration**
- Concentration
  - 4 mg/250 mL = 16 mcg/CC
- Dose range
  - 1 mg/10ml IV push of 1:1000 every 3-5 minutes
  - IV gtt: 2-10 mcg/min
- Onset/ Duration
- Titration rate
  - 0.1–0.5 mcg/kg/minute
- Monitoring Parameters
  - HR, MAP, SVR
  - Peripheral necrosis
  - Myocardial ischemia
  - Arrhythmias

**Afterload: Vasopressin**

**Action Information**
- Uses: hypotension in sepsis
- Naturally occurring anti-diuretic hormone (non catecholamine)
  - Increase water permeability at the renal tubules
  - Decrease UO
  - Increase osmolality
- Peripheral vasoconstrictor - V1
  - Causes smooth muscle contraction in all parts of the vascular bed.
  - Increase responsiveness to catecholamine
- As shock progresses levels of vasopressin fall.

**Administration**
- Concentration
  - 100 units/250 mL = 0.4units/ml
- Dose range
  - IV gtt: .04– 1.0 units/ min
- Onset/ Duration
- Titration rate
  - Do Not Titrate
    - This allow for titration / weaning of catecholamine drips
- Monitoring Parameters
  - Electrolytes
  - Osmolality – urine and serum
  - Acidosis

**LOW Afterload**

- Vasoconstrictor
  - Alpha agonist
- Central IV only
  - Large pool of blood
- Extravasation
  - Regitine

**Regitine**

**Action Information**
- Vasodilator
- Infiltrate affected area
- Give as soon as possible
  - At level of at least 12 hours of extravasation

**Administration**
- Concentration
  - 10mg/ 10 ml NS
- Dose range
  - < 5 cm diameter: 5mg around site
  - >5 cm diameter: >10 mg around site
- Onset/ Duration
- Titration rate
  - NA
- Monitoring Parameters
### Medication that Affect Contractility

**Inotropes**
- Dopamine
- Dobutamine
- Milrinone

### Contractility: Dopamine

**Action information**
- Acts both inotropic and vasoactive and dopaminergic receptor stimulating actions
- **Natural catecholamine**
- **Side Effects**
  - Increased MvO2 = angina
  - Tachycardia
- **Alerts**
  - Central line
  - Avoid extravasation!!!
  - Incompatible with sodium bicarbonate

| More than 20 mcg needed consider adding norepinephrine |

**Administration**
- **Concentration**
  - 200 mg/250 ml =800 mcg/CC
- **Dose range**
  - Low dose (1-5 mcg/kg/min)
  - Moderate dose (5-10 mcg/kg/min)
  - High dose (>10 mcg/kg/min) Alpha
- **Onset/ Duration**
  - 5 minutes
- **Titration rate**
  - 1-2 mcg/kg/min
- **Monitoring Parameters**
  - HR, BP
  - Effects diminished in acidosis

### Contractility: Dobutamine

**Action information**
- Synthetic catecholamine chemically related to dopamine
- **Action**: positive inotropic beta stimulator
  - Increases cyclic AMP concentration in cells
  - Increases SV via increasing CO
  - Short term CHF and RV failure

| Non glycoside non-adrenergic inotrope |

| Positive Inotropes (SV) and Vasodilatation afterload reduction (SVR) |

| Positive Dromotropic |

| Short term CHF and RV failure |

| Caution |

| Hypotension |

| NOT compatible with lasix |

| Consider drug to be INCOMPATIBLE unless stated to be compatible |

**Administration**
- **Concentration**
  - 250 mg/250 mL = 1000 mcg/cc
- **Dose range**
  - 2 to 20 mcg/kg/min
  - Start at: 1-5 mcg/kg/min
- **Onset/ Duration**
  - 1-10 min
  - Half life of 2 minutes
- **Titration rate**
  - Titrate 2-10 min 1-2 mcg
- **Monitoring Parameters**
  - Titrate to MAP or SV
  - Myocardial ischemia
  - CO

### Contractility: Milrinone

**Action information**
- Non glycoside non-adrenergic inotrope
- Increases cyclic AMP concentration in cells

| Positive Inotropes (SV) and Vasodilatation afterload reduction (SVR) |

| Positive Dromotropic |

| Short term CHF and RV failure |

| Caution |

| Hypotension |

| NOT compatible with lasix |

| Consider drug to be INCOMPATIBLE unless stated to be compatible |

**Administration**
- **Concentration**
  - 20 mg/100 cc = 200 mcg/ml
- **Dose range**
  - 50 mcg/mg/min over 10 minutes
  - 0.75 min/4-6 minutes
  - 0.125 min/2 minutes
  - 0.25 min/1 minute
  - 0.5 min/30 minutes
- **Onset/ Duration**
  - 10 min post load
  - Titration rate
  - 0.25 mcg/kg/min
- **Monitoring Parameters**
  - Drop B/P
  - AF will increase RVR
  - AF
- **RF=decrease dosage by 1/2**
Sedation

53%-70% of patients get sedation in the ICU.

Goals

- Patient comfort
- Decrease anxiety and stress
- Inadequate pain relief often causes agitation
- Pain relief often results in less than desired levels of sedation
- 10 years ago
- Now comfortable and easily arousable

Inadequate pain relief often causes agitation

Goals

- Patient comfort
- Decrease anxiety and stress
- Pain relief often results in less than desired levels of sedation
- 10 years ago
- Now comfortable and easily arousable

RASS Goal

-4 Combative
-3 Very Agitated
-2 Agitated
-1 Restless
0 Alert and calm
-1 Drowsy
-2 Light sedation
-3 Moderate sedation
-4 Deep sedation
-5 Un-arousable

RASS Application

1. Observe patient
   - ALERT: Is alert, restless, or agitated
   - 0 to +4
   - A. Patient is alert, restless, or agitated
   - B. Patient awakens with sustained eye opening and eye contact.
   - C. Patient has any movement in response to voice but no eye contact.
   - 0
   - 1
   - 2
   - 3

2. If not alert, state patient's name and say to open eyes and look at a speaker.
   - A. Patient awakens with sustained eye opening and eye contact.
   - B. Patient awakens with eye opening and eye contact, but not sustained.
   - C. Patient has any movement in response to voice but no eye contact.
   - -1
   - -2
   - -3

3. When no response to verbal stimulation, physically stimulate patient by shaking shoulder and/or rubbing sternum.
   - A. Patient has any movement to physical stimulation.
   - B. Patient has no response to any stimulation.
   - -4
   - -5

RASS Goals

- Alert and calm
- Drowsy
- Light sedation
- Moderate sedation
- Deep sedation
- Un-arousable

Benzodiazepines

- Most frequently used agents for sedation in the ICU
- Benzodiazepines bind to the GABA receptors located in the central nervous system.
- Provide sedation, decreased anxiety anticonvulsant, muscle relaxant and induce amnesia
- Monitor mental status, LOC resp. rate
- Side effects
  - Respiratory depression
  - Excessive sedation
  - Confusion
  - Paradoxical effect in the elderly.

Benzo

Versed Midazolam
- Short acting
- Bolus .5-4mg IVp
- Infusion 1-7 mg/h

Ativan Lorazepam
- Intermediate acting
- Water insoluble it is diluted in propylene glycol.
- Must be diluted
- Use in line filter.
- .5-4mg IV
- Infusion 2-6mg/h

Diazepam - Valium
- Long acting benzodiazepine
- Faster onset of action than Ativan and Versed

Flumazenil

- Benzodiazepine receptor antagonist that will reverse sedation amnesia and psychomotor impairment associated with benzodiazepine use.
- Reversal of conscious sedation:
  - .2mg IV over 2 minutes wait 45 sec
  - .2mg repeated as needed to max of 1mg
### Sedation: Propofol

**Action information**

**Sedative:**
- Hypnotic, general anesthetic

**Sedation of intubated pt.:**

**Lipid base:**
- Provides 1.1 calories/ml

**Administration**

- **Concentration**
  - $1000 \text{ mcg}/100\text{cc} = 10 \text{mcg/cc}$

- **Dose range**
  - 10-100mcg/kg/min
  - Normal 20-50mcg/kg/min

- **Onset / Duration**
  - 2 minutes
  - 10 minutes

- **Titration rate**
  - Begin with 5mcg/kg/min
  - Increase by 5-10mcg/kg/min every 5/10 minutes

- **Monitoring Parameters**
  - LOC
  - BP
  - Serum triglycerides

---

### Neuromuscular Blocking Agents

Used primarily to obtain protect and maintain a safe airway and to assist with mechanical intubations.

No sedative amnesic anesthetic or analgesic properties

<table>
<thead>
<tr>
<th>Drugs</th>
<th>Indication</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vecuronium, atracurium</td>
<td>Severe lung pathology</td>
<td>Train of Four (0-4)</td>
</tr>
<tr>
<td>cisatracurium</td>
<td>Mechanical ventilation</td>
<td>Frequent turns</td>
</tr>
<tr>
<td>Pancuronium</td>
<td>Seizures or increased ICP with excessive muscular movement</td>
<td>Eye care</td>
</tr>
<tr>
<td>long-acting</td>
<td>Excessive shivering</td>
<td>Sedation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suctioning</td>
</tr>
</tbody>
</table>

### Potassium

- Potassium is essential for the maintenance of the electrical membrane potential

- **Hyperkalemia**
  - Renal dysfunction
  - Acidosis
  - Drugs (potassium sparing diuretics, ace inhibitors, succinylcholine
  - Rhabd.
  - Burns

### EKG Changes

- Tall tented t waves
- Qt interval may shorten
- Intra-ventricular conduction is slowed
- Widened QRS
- Wide p waves
- Bradycardia, 1st degree AV block, VF, asystole

**NORMAL**

- A
- B
- C
- D
- E
- F
- G
- H
- I
- J
- K
- L
- M
- N
- O
- P
- Q
- R
- S
- T
- U
- V
- W
- X
- Y
- Z
**Treatment**

- Temporary: one amp D50, 10 units regular insulin this drives k+ into the cell
- Calcium 1 amp elevates stimulation threshold
- Bicarb one amp moves k+ into cell
- Kayexalate
- Dialysis

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**Pharmacology First Thing First**

- Low B/P + Low filling Pressure = Volume
- Low B/P + Acceptable filling Pressure = Inotropes / vasoconstrictor
- Acceptable or High B/P + high filling pressures = Vasodilator
- High B/P + low filling Pressures = Volume + vasodilator

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**Simulation Case Study**

- Mr. Stabler is a 71 year old male admitted for 3 vessel CABG. He has just been settled and initial lab work is pending. EBL 1000 ml OR crystalloids 2100 ml and colloids 1000 ml. Patient is intubated and sedated: unable to speak CPB time 3 hr 20 mins Clamp time 2 hr 26 mins. BAS 1.85 = 6’/168cm x 180lb/82kg
- ESRD, renal transplant, PVD, history for fem pop bypass to left leg.
- Increasing angina and SOB over past year.
- Abnormal stress test → angiogram showed multi-vessel disease.
- CAD, HTN, Aftib with ablation, permanent pacemaker

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**Titrate to OFF**

- **Dopamine** 5 mcg/kg/min
- **NTG** 0.05 mcg/kg/min
- **Epinephrine** 0.06 mcg/kg/min
- **Milrinone** 0.5 mcg/kg/min
- **Propofol** 50 mcg/kg/min
- **Vasopressin** 3 units /hr
Simulation Case Study

Mr. Acuity 81 YO male. Admitted for AVR/CAB 3 vessel LIMA to LAD, SVG to RCA, SVG to OM1
BSA BSA= 2.8 6.1/185 cm x 210lbs/95 kg

Had pre-syncopal episode found to have severe AS
SOB and Shoulder pain for last 2 years.
PAD, prostatectomy, HTN, CAD, AS, appendectomy
Tobacco use 50 pack year

Pharmacology Critical Thinking

Know
• What you are doing?
Know
• Why you are doing it?
Know
• What will happen?
Know
• What are you going to do about it?

Titrate to Stable

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dopamine</td>
<td>3 mcg/kg/min</td>
</tr>
<tr>
<td>NTG</td>
<td>.5 mcg/kg/min</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>.06 mcg/kg/min</td>
</tr>
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</tr>
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<td>Propofol</td>
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</tr>
</tbody>
</table>

Titrate to Goal

Know how much more information do you want?