

	MEDICATION	BOLUS DOSE	INFUSION DOSE (mcg/kg/min)	RECEPTOR(S)	HR	BP	CO	SVR	PVR
Pressor	Angiotensin II	-	0.01 - 0.04	A-II type 1	↓	↑↑↑	varies	↑↑↑	↑↑
	Phenylephrine	50 - 100 mcg	0.1 - 0.7	α ₁	↓	↑↑↑	varies	↑↑↑	↑↑
	Vasopressin	-	0.01-0.10 units/min	V ₁ > V ₂	↓	↑↑↑	↔/↓	↑↑↑	varies
Inopressor	Calcium Chloride	250 - 1000 mg	-	-	↔	↑	↑	↑	↑
	Dopamine	-	1 - 4	DA ₁	↔	↓	↑	↓	
			5 - 10	β	↑	varies	↑↑	varies	
			10 - 20	α	↑↑	↑↑↑	↑	↑↑	↑
	Ephedrine	5 - 10 mg	-	α ₁ > β ₁	↑	↑	↑	↑	
	Epinephrine	5 - 10 mcg	0.01 - 0.20	α and β	↑↑	↑↑	↑↑	varies	
Norepinephrine	5 - 10 mcg	0.01 - 0.20	α ₁ > β ₁	↑	↑↑	↔/↑	↑↑↑	↔	
Ino-dilator	Dobutamine	-	2 - 20	β ₁ and β ₂	↑↑	varies	↑↑↑	↓	↓
	Isoproterenol	-	1 - 20 mcg/min	β ₁ and β ₂	↑↑↑	varies	↑↑↑	↓	
	Milrinone	25 - 50 mcg/kg	0.125 – 0.75	↑ cAMP	↑↑	varies	↑↑↑	↓↓	↓↓
β - Blocker	Esmolol	10 - 50 mg	10 - 50	β ₁	↓↓	↓	↓	↔	
	Labetalol	5 - 20 mg	-	β ₁ , β ₂ , and α ₁	↓	↓↓	↓↓	↓	
	Metoprolol	5 - 20 mg	-	β ₁	↓↓	↓	↓	↔	
CCB	Clevidipine	-	1 - 16 mg/hr	DHP-CCB	↔/↑	↓↓	↔/↑	↓↓↓	
	Nicardipine	-	1 - 15 mg/hr	DHP-CCB	↔/↑	↓↓	↔/↑	↓↓↓	
	Diltiazem	5 - 20 mg	5 - 20 mg/hr	non-DHP-CCB	↔/↓	↓	↓		
	Verapamil	2.5 - 10 mg	-	non-DHP-CCB	↓	↓	↓		
Dilator	Hydralazine	5 - 20 mg	direct arterial vasodilator		↑	↓↓	↑	↓↓	↓
	Nitroglycerin	50 - 200 mcg	0.5 - 10	venodilation > vasodilation					
	Nitroprusside	50 - 200 mcg	0.5 - 10	vaso = venodilation, cyanide toxicity					
Hypnotic	Dexmedetomidine	0.5 - 1.0 mcg/kg (over 10 min)	0.2 - 1.4 mcg/kg/hr	α ₂ >> α ₁	anxiolytic, weak analgesic, preserves respiratory drive, bradycardia/hypoTN				
	Etomidate	0.2 - 0.3 mg/kg	-	GABA _A	↑	↓/↔	↔	↓/↔	
	Ketamine	1 - 2 mg/kg	1 - 5	NMDA	↑↑	↑↑	↑↑	↔/↑	
	Midazolam	0.1 - 0.3 mg/kg	0.2 - 1.5	GABA _A	↔/↑	↓	↔	↓	
	Propofol	1 - 2.5 mg/kg	25 - 200	GABA _A	↑	↓↓	↓/↔	↓↓	
Paralytic	Cisatracurium	0.15 mg/kg	1 - 5	nAChR	metabolized in plasma				
	Rocuronium	0.6 - 1.2 mg/kg	5 - 10	nAChR	sugammadex reversal (2, 4, 16 mg/kg)				
	Succinylcholine	1 mg/kg	-	nAChR	MH trigger: avoid in acute burns, denervation injury, prolonged immobility, severe infection				
Opioid [rel. potency]	Fentanyl [100x]	12.5 - 100 mcg	25 - 200 mcg/hr	long context-sensitive half-life					
	Hydromorphone [5-10x]	0.2 - 1 mg	0.5 - 4 mg/hr	H3G metabolite may cause neuroexcitation					
	Meperidine [0.1x]	10 - 25 mg	↓ shivering (kappa-opioid receptor activation)						
	Methadone [4x]	0.2 - 0.3 mg/kg	t _{1/2} ~ 1-2 days, NMDA effects, ↑ QT _c						
	Morphine [1x]	2 - 5 mg	2 - 10 mg/hr	active M6G metabolite ↑ in renal dz					
	Remifentanyl [100-300x]	1 mcg/kg	0.05 - 2	metabolized in plasma					
Sufentanil [1000x]	0.25 - 2 mcg/kg	0.1 - 1 mcg/kg/hr							
Anti-emetic	Dexamethasone	4 mg	steroidal						
	Diphenhydramine	12.5 - 50 mg	H ₁ receptor blockade, sedating						
	Haloperidol	1 - 5 mg	anti-DA, QT prolongation						
	Lorazepam	0.5 - 2.0 mg	GABA-ergic						
	Metoclopramide	5 - 10 mg	anti-DA, tardive dyskinesia						
	Olanzapine	2.5 - 10 mg PO	anti-DA						
	Ondansetron	4 - 8 mg	anti-5HT						
	Promethazine	6.25 - 25 mg	anti-histamine, sedating						
	Scopolamine	1 patch	anti-muscarinic, not MRI compatible						
	Adrenergic receptors: α1 (vasoconstriction), α2 (presynaptic negative feedback ↓ sympathetic outflow), β1 (↑ HR and contractility, ↑ renin), β2 (bronchodilation, vasodilation in skeletal muscle, ↑ insulin secretion, glycogenolysis/gluconeogenesis)								
	PARAMETER	EQUATION		NORMAL VALUES					
Hemodynamic	Heart Rate (HR)	-		60-100					
	Cardiac Output (CO)	HR x SV		4 - 8 L/min					
	Cardiac Index (CI)	CO / BSA		2.5 - 4.0 L/min/m ²					
	Stroke Volume (SV)	(CO / HR) x 1000		50 - 100 cc/beat					
	Stroke Index (SI)	SV / BSA		40 - 60 cc/beat/m ²					
	Shock Index	HR / SBP		0.5 - 0.7					
Pressure	Systolic BP (SBP)	-		90 - 140 mmHg					
	Diastolic BP (DBP)	-		60 - 90 mmHg					
	Pulse Pressure (PP)	SBP - DBP		20 - 70 mmHg					
	Mean Arterial (MAP)	(2/3 x DBP) + (1/3 x SBP)		60 - 100 mmHg					
	Right Atrium (RAP) / CVP	-		2 - 6 mmHg					
	Right Ventricle	-		15 - 25 mmHg / 0 - 8 mmHg					
	Pulmonary Artery	-		15 - 25 mmHg / 8 - 15 mmHg					
	PA Occlusion ("wedge")	-		6 - 12 mmHg					
	Left Atrium	-		6 - 12 mmHg					
	Coronary Perfusion Pressure (CPP)	DBP - LVEDP (to LV) or DBP - RVEDP (to RV)		60 - 80 mmHg					
Resistance	SVR	[(MAP - CVP) / CO] x 80		750 - 1500 dynes-sec/cm ⁵					
	SVRI	[(MAP - CVP) / CI] x 80		1500 - 2400 dynes-sec/cm ⁵					
	PVR	[(mPAP - PAOP) / CO] x 80		50 - 200 dynes-sec/cm ⁵					
	PVRI	[(mPAP - PAOP) / CI] x 80		50 - 225 dynes-sec/cm ⁵					
Gas Exchange And Delivery	FiO2	fraction of inspired O ₂ = 0.21 - 1.00 (often given as fraction, 0.21 = room air)							
	P _b	barometric pressure = 0 - 760 mmHg (760 mmHg at sea level)							
	Respiratory Quotient (RQ)	0.7 (only lipids), 0.8 (balanced diet), 1.0 (only carbs)							
	Alveolar Gas Equation	P _A O ₂ = F _i O ₂ (P _b - P _{H2O}) - P _a CO ₂ / RQ		P _{H2O} ~47 mmHg at sea level		~100 mmHg at sea level			
	P _A CO ₂ Equation	P _A CO ₂ = (VCO ₂ x 0.863) / V _A							
	P/F Ratio	P _a O ₂ / F _i O ₂		> 400					
	A-a Gradient	P _A O ₂ - P _a O ₂		7 mmHg (young)		15 mmHg (elderly)			
	Respiratory Index	RI = (P _A O ₂ - PaO2) / P _a O ₂		< 0.4					
	Arterial O ₂ Content	C _a O ₂ = (1.34 x [Hb] x [S _a O ₂]) + (0.003 x P _a O ₂)		17 - 20 cc O ₂ /100 cc					
	Mixed Venous O ₂ Content	C _v O ₂ = (1.34 x [Hb] x [S _v O ₂]) + (0.003 x P _v O ₂)		12 - 15 cc O ₂ /100 cc					
Antidote	Arteriovenous Difference	C _a O ₂ - C _v O ₂		4 - 5 cc O ₂ /100 cc					
	Fick O ₂ Consumption	VO ₂ = 10 x CO x (C _a O ₂ - C _v O ₂)		3.5 cc O ₂ /kg/min					
	Fick Cardiac Output	CO = VO ₂ / [10 x (C _a O ₂ - C _v O ₂)]		4 - 8 L/min					
	Anticholinergic	Physostigmine 0.5 - 2 mg IV							
	Acetylcholinesterase	Atropine 0.5 mg q3m PRN, PAM 1-2 grams IV over 30 minutes							
	Benzodiazepine	Flumazenil 0.2 mg IV q1m PRN (seizure risk)							
Beta-Blocker	Glucagon 5 mg IV then 2-5 mg/hr, insulin+glucose, pacing								
CCB	Calcium repletion								
Carbon Monoxide	O ₂ therapy (hyperbaric O2 if AMS, MI, > 55 y/o, pregnant)								
Cyanide	Cyanokit 5 g IV or 4-DMAP/nitrates + sodium thiosulfate								
Digoxin	DigiFab 400 mg IV								
Local Anesthetic	Intralipid 1.5 cc/kg then 15 cc/kg/hr, use 1 mcg/kg epi for ACLS								
Malignant Hyperthermia	Stop succinylcholine/volatile anesthetic, dantrolene 2.5 mg/kg (up to 10 mg/kg), hyperventilate, ↑ oxygen, cool patient								
Methemoglobinemia	Methylene blue 1-2 mg/kg IV (not in G6PD deficiency) or VitC								
Opioids	Naloxone 40 mcg IV (to effect)								
Poison Control: 1-800-222-1222; MH Hotline: 800-644-9737									

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1° DISORDER	PH	P _a CO ₂	[HCO ₃]	COMPENSATION
AG/non-AG Metabolic Acidosis	↓	↓ (2°)	↓ (1°)	$P_{aCO_2, \text{ expect }} = 1.5 [HCO_3^-] + 8 \pm 2$ If $P_{aCO_2, \text{ actual }} < P_{aCO_2, \text{ expect }}$ also 1° respiratory alkalosis If $P_{aCO_2, \text{ actual }} > P_{aCO_2, \text{ expect }}$ also 1° respiratory acidosis
AG Acidosis "Delta/Delta"	For AG metabolic acidosis, calculate $\Delta AG / \Delta [HCO_3^-] = (AG - 12) / (24 - [HCO_3^-])$ if < 0.8, non-AG acidosis ; if > 2, metabolic alkalosis			
Metabolic Alkalosis	↑	↑ (2°)	↑ (1°)	$P_{aCO_2} = 0.7 \times [HCO_3^-] + 20 \pm 5$ If $P_{aCO_2, \text{ actual }} < P_{aCO_2, \text{ expect }}$ also 1° respiratory alkalosis If $P_{aCO_2, \text{ actual }} > P_{aCO_2, \text{ expect }}$ also 1° respiratory acidosis
Respiratory Acidosis	↓	↑ (1°)	↑ (2°)	For each ↑ 10 mmHg in P _a CO ₂ Acute: ↑ [HCO ₃ ⁻] 1 mmol/L and ↓ pH 0.08 Chronic: ↑ [HCO ₃ ⁻] 4 mmol/L and ↓ pH 0.03
Respiratory Alkalosis	↑	↓ (1°)	↓ (2°)	For each ↓ 10 mmHg in P _a CO ₂ Acute: ↓ [HCO ₃ ⁻] 2 mmol/L and ↑ pH 0.08 Chronic: ↓ [HCO ₃ ⁻] 5 mmol/L and ↑ pH 0.03
Primary disorder (1°), compensation (2°); arrows relative to baseline P _a CO ₂ ~ 40 mmHg and [HCO ₃ ⁻] ~ 24 mEq/L				

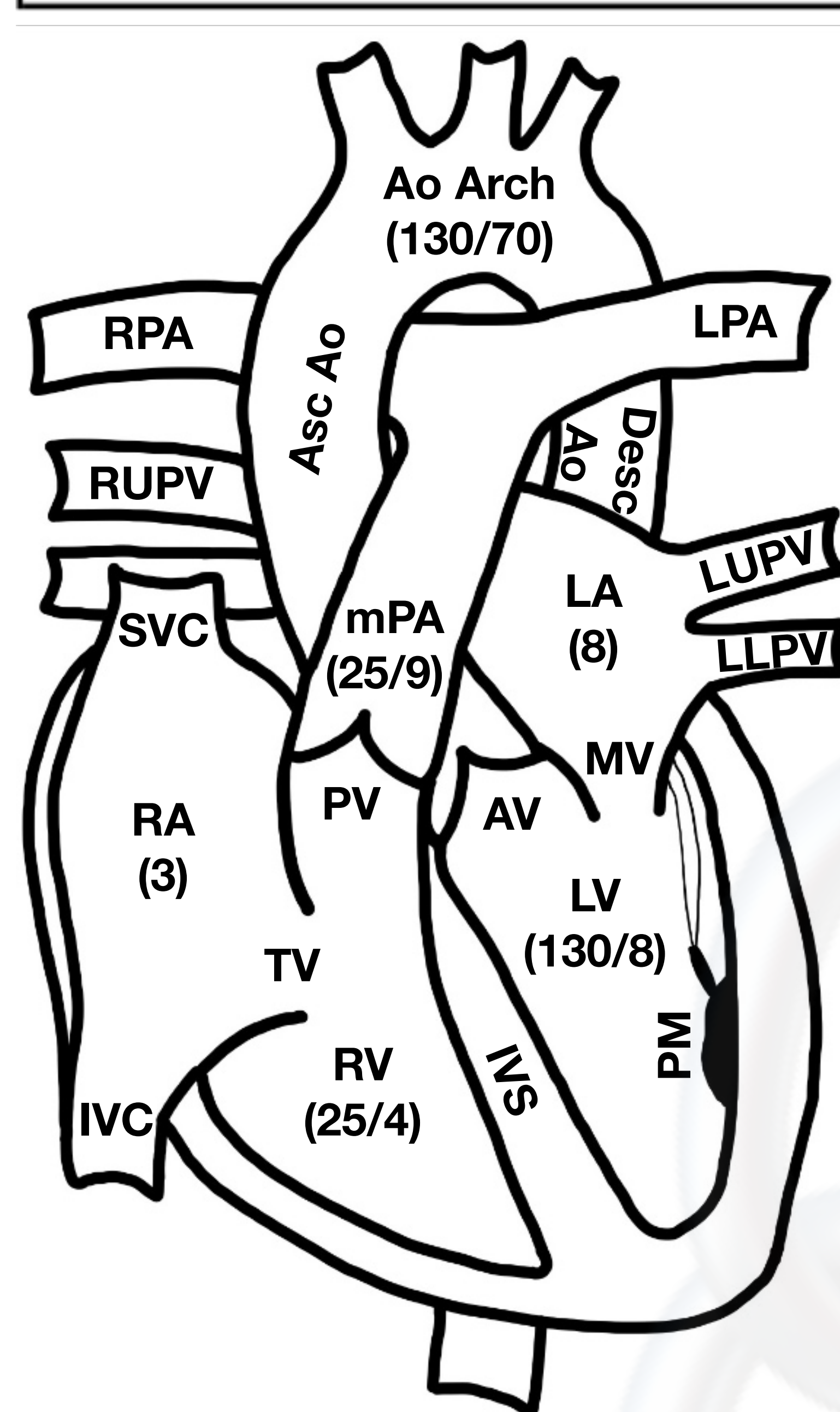
Response	Action	Score
Eye ("four eyes")	Spontaneous opening	4
	Open to command	3
	Open to pain	2
	No opening	1
Motor ("V6 engine motor")	Follows commands	6
	Purposely movement to pain	5
	Withdraws from pain	4
	Abnormal flexion, decorticate	3
	Abnormal extension, decerebrate	2
	No motor response	1
Verbal ("the Jackson 5")	Oriented	5
	Confused but answers questions	4
	Inappropriate, words discernible	3
	Incomprehensible	2
	No verbal response	1

GCS score ranges from 3 to 15. If **intubated**, cannot perform verbal section. 'T' is affixed to score (ie, GCS 8T).

Brain injuries: mild (GCS 13-15), moderate (GCS 9-12), severe (GCS 3-8)

	SBP	SVR	CVP	CO	PAP	PAOP	PVI
Cardiogenic Shock	↓	↑	↑	↓	↑	↑	↑
Cardiac Tamponade	↓	↑	↑	↓	↑	↑	↔
Hypovolemic Shock	↓	↑	↓	↓	↓	↓	↑
Neurogenic Shock	↓	↓	↓	↓	↓	↓	↓
Pulmonary Embolism	↓	↑	↑	↓	↑	↔/↓	↑
Septic Shock	↓	↓	↓	↑	↓	↓	↓

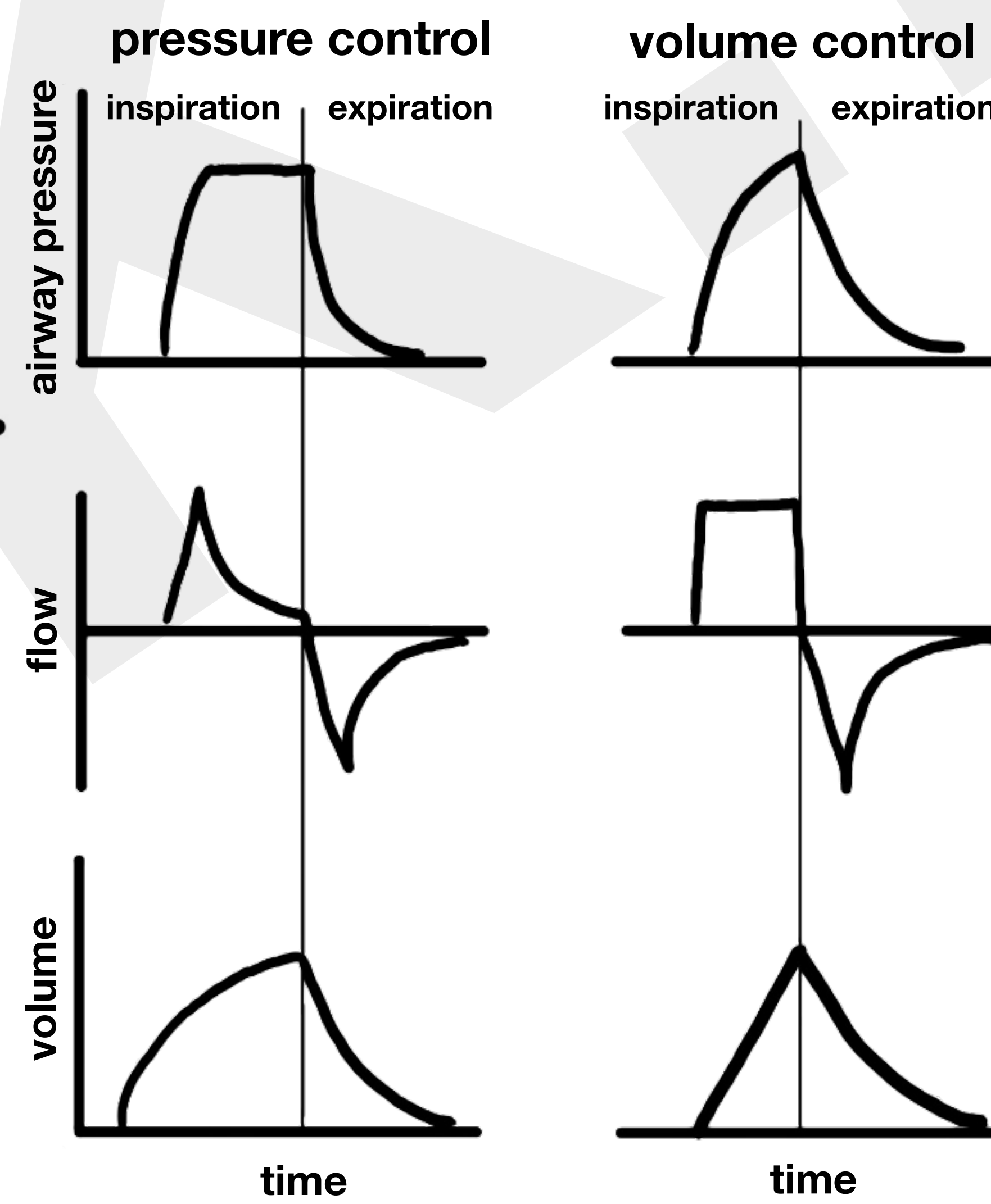
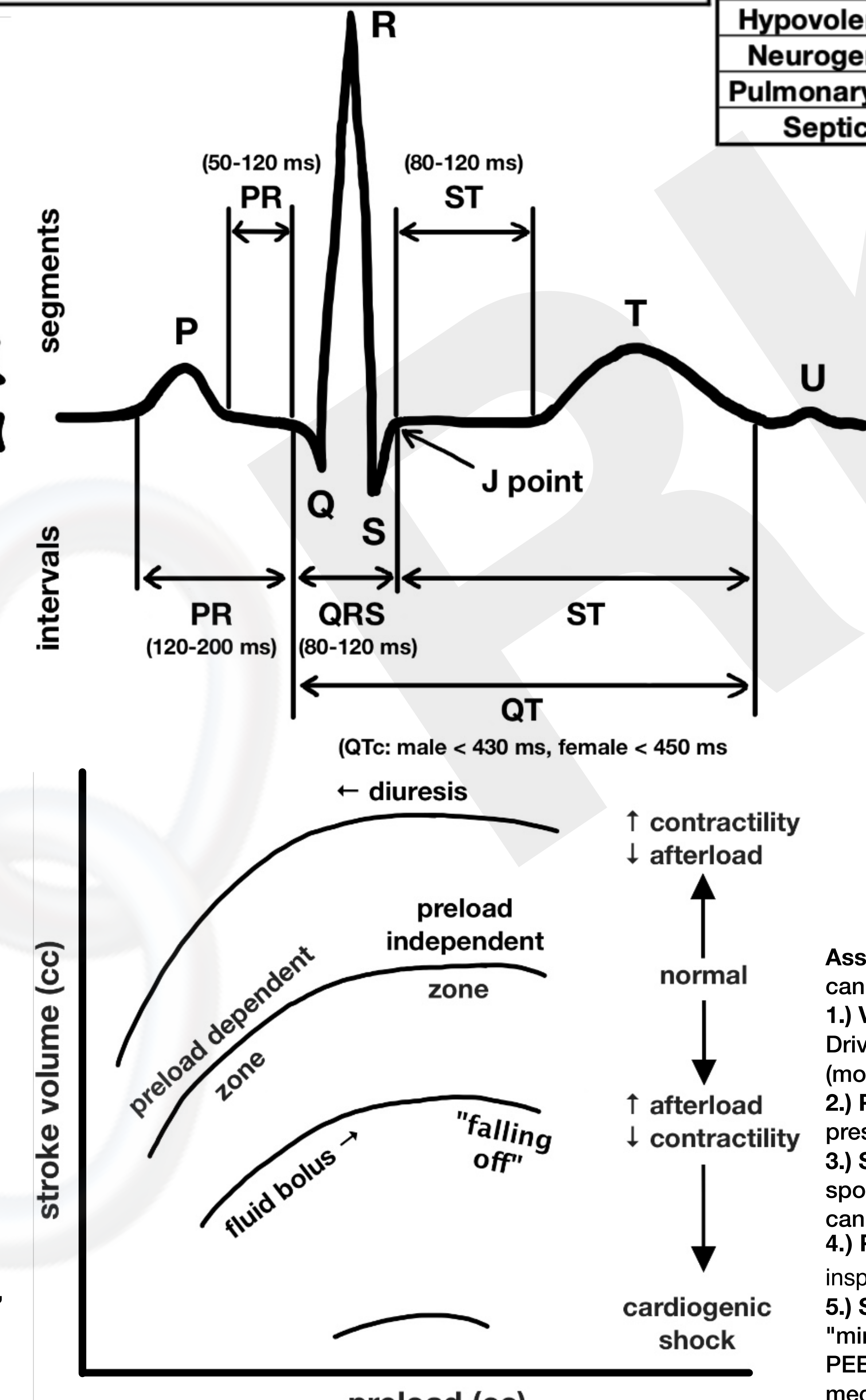
Score	Term	Description
+ 4	combative	violent, danger to self/staff
+ 3	very agitated	pulls tubes/catheters, aggressive
+ 2	agitated	frequent, non-purposeful movement
+ 1	restless	anxious but not aggressive
0	calm and alert	
- 1	drowsy	sustained awakening (> 10 sec) to voice
- 2	light sedation	briefly (< 10 sec) awakens to voice
- 3	moderate sedation	any movement (but no eye contact) to voice
- 4	deep sedation	no response to voice but responds to physical stimuli
- 5	unarousable	no response to verbal/physical stimuli
RASS goal typically -2 to 0. RASS > +2 should be assessed for delirium, anxiety, and/or pain.		
M: 13.5 - 17.5 W: 12 - 15.5	Na ⁺ 135-145	Cl ⁻ 95-105
BUN 8-21	glucose 70-100	Ca ²⁺ : 8 - 10
Mg ²⁺ : 1.7 - 2.2	PO ₄ ³⁻ : 2.5 - 4.5	
M: 45-52% W: 37-48%	Hgb 150 - 450K	K ⁺ 3.5-4.5
PT 11-14s	aPTT 20-40s	pH 7.35-7.45
P _a CO ₂ 35-45	P _a O ₂ 80-100	HCO ₃ ⁻ 22-26
INR 0.9-1.2		



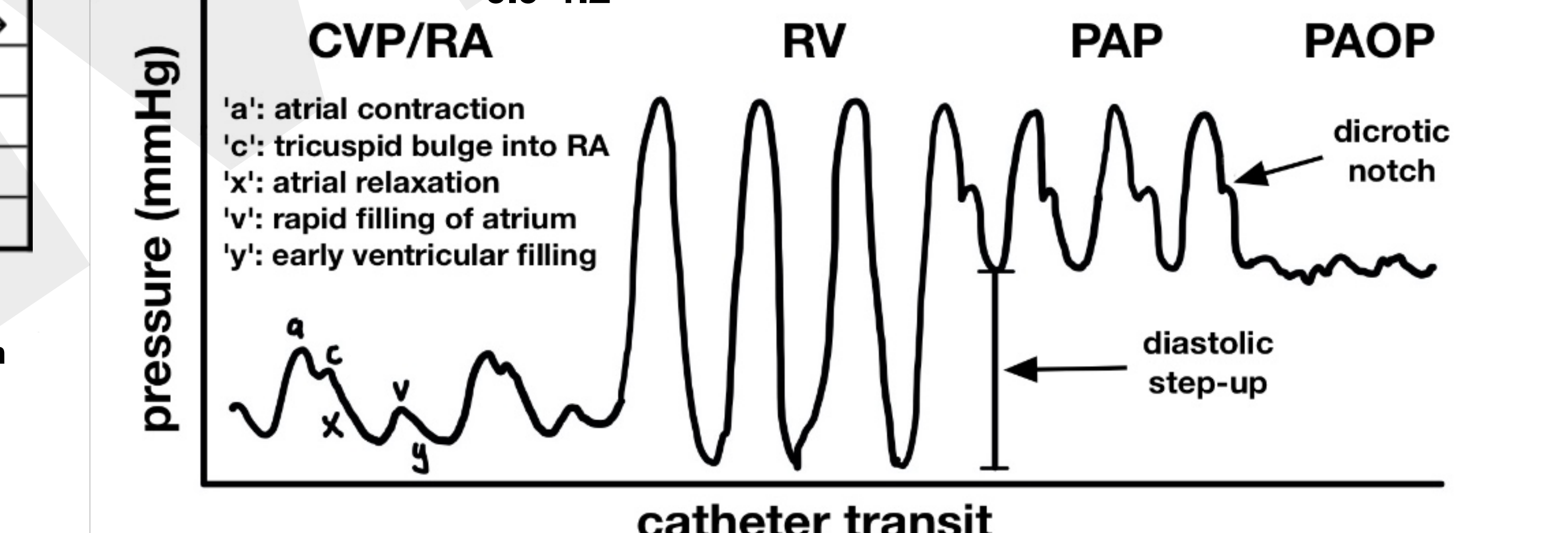
Chambers/Vessels (normal mean chamber pressure in mmHg)

Blood Flow: SVC/IVC → RA → RV → mPA → LA → LV → Asc Ao

Abbreviations: superior/inferior vena cava (SVC/IVC), right/left atrium (RA/LA), right/left ventricle (RV/LV), main/right/left pulmonary artery (mPA/RPA/LPA), right upper/left upper/left lower pulmonary vein (RUPV/LUPV/LLPV), tricuspid/pulmonic/mitral/aortic valve (TV/PV/MV/AV), interventricular septum (IVS), papillary muscle (PM), aorta (Ao)



Assist Control (AC): ventilator "controls" breathing while patient can "assist" with additional, fully supported breaths
1.) Volume Control (AC-VC): AC mode with set tidal volume (V_T). Driving pressure will depend on compliance. PEEP, F_{O2}, RR also set (mode guarantees a minute ventilation).
2.) Pressure Control (AC-PC): AC mode with set inspiratory pressure. V_T based on compliance. PEEP, F_{O2}, RR adjustable.
3.) Synchronized Intermittent Mandatory Ventilation (SIMV): spontaneous breaths are NOT fully supported (they get what they can pull). Therefore, V_T can vary
4.) Pressure Support (PS): spontaneous breaths receive an inspiratory pressure support. PEEP and F_{O2} can be adjusted.
5.) Spontaneous Breathing Trial (SBT): typically performed on "minimals" (5 mmHg of inspiratory pressure on top of 5 mmHg PEEP) with minimal oxygen (F_{O2} < 0.4) to assess pulmonary mechanics, ABG, etc. to determine feasibility for extubation.



	CAUSES	SYMPTOMS	TREATMENT
↑ Na (> 145)	dehydration, ↓ thirst, DI, GI losses, osmotic diuresis, Na overload	AMS, weakness, lethargy, seizures, coma	correct free H ₂ O deficit (FWD) (~10 mEq/24 hrs if chronic, 1-2 mEq/hr if acute)
↓ Na (< 136)	CHF, cirrhosis, nephrosis, SIADH, diuretics, salt wasting, polydipsia	headache, lethargy, nausea, seizures, coma	H ₂ O restriction, If CNS symptoms: hypertonic saline (↑ Na < 10-12 mEq/24 hrs)
↑ K (> 5)	K-sparing diuretics, acidosis, ↓ Na, trauma, hemolysis, rhabdo, tumor lysis, ↓ aldosterone	abdominal pain, confusion, paralysis, arrhythmias , peaked T wave, prolonged PR	calcium, dextrose/insulin, bicarbonate, diuretics, Kayexalate, Lokelma, dialysis
↓ K (< 3.5)	↓ intake, diuretics, GI losses (vomiting, diarrhea, gastric suctioning)	lethargy, weakness, arrhythmias , ileus, U wave, ↑ QT	oral/IV K repletion
↑ Ca (> 10.4)	↑ PTH, granulomatous dz, ↑ Vit D, malignancy	renal stones, abdominal pain, AMS, ↓ QT	fluids, loop diuretics, bisphosphonates
↓ Ca (< 8.8)	poor intake, ↓ Vit D, ↓ PTH, ↑ Phos, citrate, pancreatitis	tetany, seiures, ↑ QT, Chvostek/Trousseau signs	oral/IV Ca repletion
↑ Mg (> 2.3)	↑ Mg intake (antacids/laxatives), CKD, Addison's dz	↓ DTRs, sedation, paralysis, weakness, arrhythmias, coma	stop Mg repletion, fluids, loop diuretics, dialysis
↓ Mg (< 1.6)	GI losses (pancreatitis, diarrhea, PPIs) and renal losses (diuretics, fluids, uncontrolled DM, alcoholism, ↑ Ca, resolved ATN)	weakness, hyperreflexia, arrhythmias, refractory hypokalemia	oral/IV Mg repletion
↑ Phos (> 4.5)	AKI/CKD, tumor lysis, hemolysis, rhabdo, bisphosphonates, laxatives	paresthesias, arrhythmias , muscle cramps, perioral tingling, ↓ Ca, renal stones	limit Phos intake, calcium acetate, sevelamer, fluids/diuretics, dialysis
↓ Phos (< 2.5)	malnutrition, refeeding, insulin, fluids/diuretics, DKA, GI losses (vomiting, diarrhea, gastric suctioning), hyperparathyroidism	muscular weakness , respiratory failure, hemolysis, ↓ inotropy, AMS	oral/IV Phos repletion