

## Preop Evaluation/Post Operative Care (Nutrition, Pain Management)

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# Care of the Surgical Patient

## Halstead Student Lecture Series

Essentials of General Surgery  
Chapters 1-3

**Frank Lee, MD**

May 22, 2015

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# Topics

- Preoperative evaluation
- Post operative care
  - Pain management
  - Fluids and electrolytes
  - Nutrition

# Pre Operative Evaluation

- Why is it important...
  - Abnormal physiologic and metabolic state
  - Stress
  - Establish a relationship with the patient
  - Determine the decision maker (patient or a surrogate)
  - Informed consent .... More than just a form
  - History and physical
  - Adjuncts to evaluation

# Obtaining a good history

- HPI – start with open question and transition to closed, specific questions
- Family history
  - especially pertinent disease processes
- Allergies and drug sensitivities
- Medication history
  - Prescription drugs
  - OTC agents
  - Herbal remedies
- ROS – be specific!
- In emergencies...AMPLE

# Adjuncts

- **Laboratory studies – selective studies**
  - Example: CBC only in patients at risk for anemia AND a surgery with expectations of high blood loss
  - Example: serum creat/lytes in only in patients with DM, HTN, heart/renal/hepatic disease, vomiting, patients on diuretics
- **Specialty consultations**

TABLE 1-3

## Recommendations for Laboratory Testing before Elective Surgery

Test	Incidence of Abnormalities That Change Management	LR+	LR-	Indications
Hemoglobin	0.1%	3.3	0.90	Anticipated major blood loss or symptoms/history of anemia
White blood count	0.0%	0.0	1.0	Symptoms suggestive of infection, myeloproliferative disease, myelotoxic medications
Platelet count	0.0%	0.0	1.0	History of bleeding disorder/bruising, myeloproliferative disease, myelotoxic medications, splenomegaly
Prothrombin time	0.0%	0.0	1.0	History of bleeding disorder/bruising, chronic liver disease, malnutrition, recent or long-term antibiotic/warfarin use
Partial thromboplastin time	0.1%	1.7	0.86	History of bleeding diathesis, anticoagulant medication
Electrolytes	1.8%	4.3	0.80	Chronic renal insufficiency, CHF, diuretic use, other meds that affect electrolytes
Renal function tests	2.6%	3.3	0.81	Age 50, hypertension, cardiac disease, major surgery, medications that may alter renal function
Glucose	0.5%	1.6	0.85	Obesity, known diabetes or symptoms thereof
Liver function tests	0.1%			No indication, consider albumin measurement for major surgery or chronic illness
Urinalysis	1.4%	1.7	0.97	No indication
Electrocardiogram	2.6%	1.6	0.96	Men > 40, women > 50, known coronary artery disease, diabetes or hypertension
Chest x-ray	3.0%	2.5	0.72	Age > 50, known cardiac or pulmonary disease or symptoms or exam findings suggesting cardiac or pulmonary disease

LR+, Likelihood ratio that a test will be abnormal in the absence of symptoms or signs; LR-, Likelihood ratio that a test will be normal in the absence of symptoms or signs; CHF, congestive heart failure.

Adapted and used with permission from Smetana GW, Macpherson DS. The case against routine preoperative laboratory testing. *Med Clin North Am* 2003;87(1):7-40.

# Cardiac Risk

- Increased risk of MI:
  - Surge in catecholamines
  - Suppression of fibrinolytic system
- Perioperative MI risk in patients with previous MI: 5-10% (with assoc. mortality of 50%)
  - If within 3 months of MI: 30% risk of additional cardiac event → 5% if wait >6 months
- Diabetes: significantly increases cardiac risk
  - 5-10 yr history of DM: 60% have vascular disease
  - >20 h/o DM: nearly 100%
- Continue perioperative betablockers and statins!



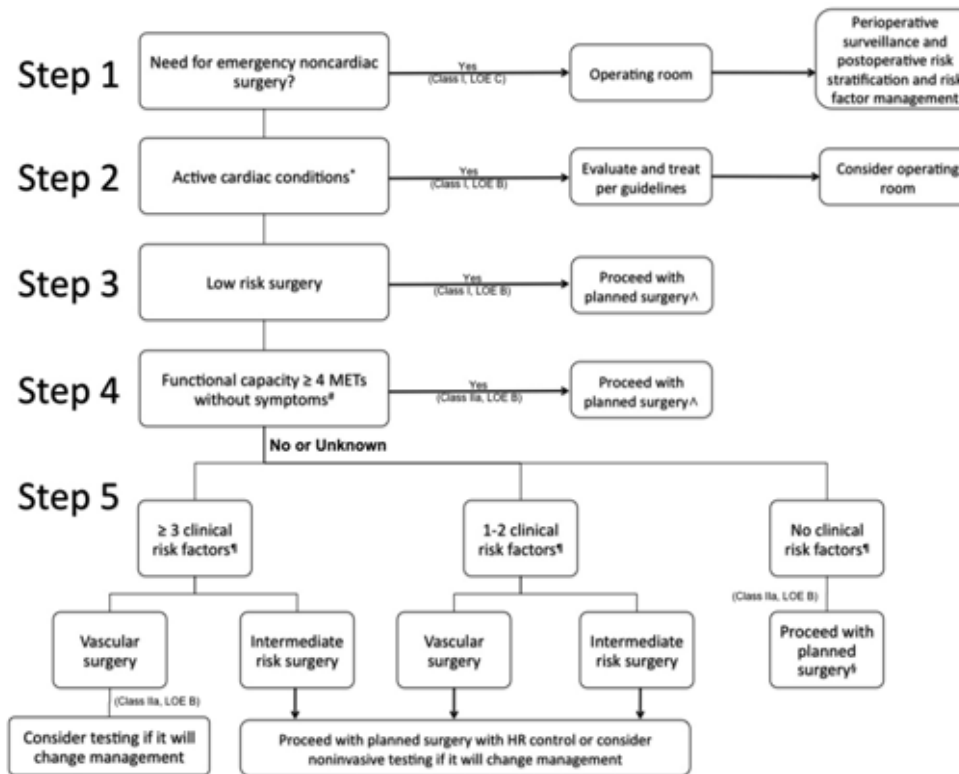
# Cardiac Risk Stratification

## ■ Drip Class

- DRIPPS I
- DRIPPS II
- DRIPPS III
- DRIPPS IV
- DRIPPS V

## ■ Rev

What are the ACC/AHA 2009 Guidelines for Preoperative Assessment?



n

monary disease

apparently found in

# Pulmonary Risk

- Good H&P to identify patients at risk:
  - Smoking hx, asthma, COPD, OSA, CHF, previous pulmonary complications, exercise tolerance, etc
- ASA score
- Modifiable factors:
  - Recommend d/c smoking 6 wks preop
  - Low serum albumin (<3.5)
- Procedure related risk factors:
  - Surgical site
  - Duration of surgery
  - anesthesia

ASA Classification of Patient	Comments
ASA I	No known systemic disease
ASA II	Mild or well-controlled systemic disease
ASA III	Multiple or moderate controlled systemic disease(s)
ASA IV	Poorly controlled systemic diseases(s)
ASA V	Moribund patient
E	Connotes emergency

# Pulmonary Risk

- Additional studies: PFTs
  - For patients at high risk or patients undergoing pulmonary surgery (dyspnea with minimal exertion, etc)
  - Minimum recommendations for proceeding without pre-op intervention due to increased risk of pna, death, VDRF:
    - FEV1 > 1L
    - PaO<sub>2</sub> > 50 mmHg
    - PaCO<sub>2</sub> < 45 mmHg
- Special considerations for patients undergoing pulmonary surgery

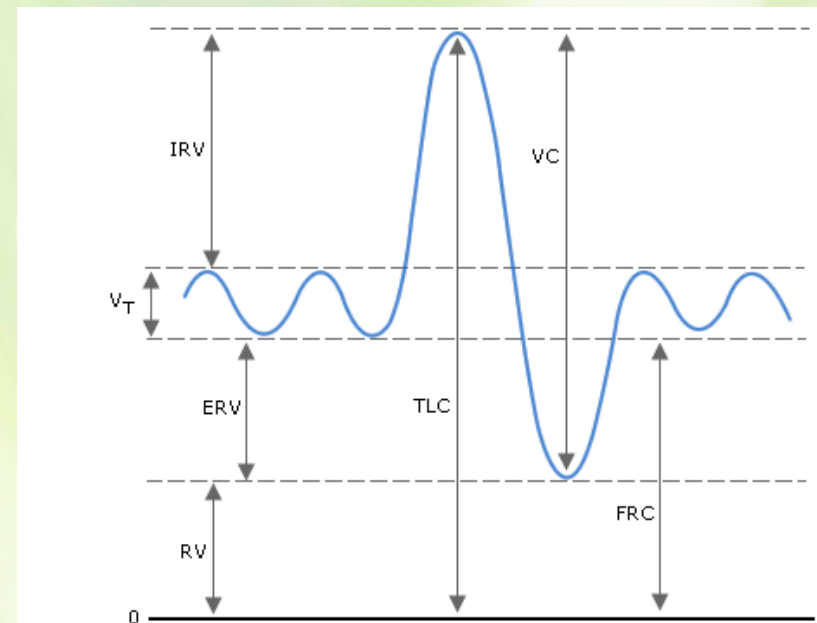


Fig 1 Spirometry trace

# Renal Dysfunction

- CKD = dysfunction for > 3 months
  - Malnourishment due to derangements in nitrogen end product metabolism
  - anemia
- Periop AKI
  - Usually due to ATN (1% risk in surgical patients)
    - Risk factors:
      - Increased age
      - PMH of kidney disease
      - LVEF < 35% or CI of <1.7 L/min/m<sup>2</sup>
      - HTN
      - PVD
      - DM
      - Emergency surgery
      - High risk surgery

# Renal Dysfunction Management

- Periop fluid optimization
  - Sometimes requiring invasive hemodynamic monitoring
- Close monitoring of electrolytes; at risk for
  - Hyperkalemia
  - Hypocalcemia
  - Hyperphosphatemia
  - Hypermagnesemia
- Daily weighing and accurate I/Os
- Avoid any nephrotoxins

# Hepatic Dysfunction

- Increased incidence due to obesity and NASH
- Frequently asymptomatic until very progressed (regardless of etiology)
- Requires thorough evaluation of risk factors and physical exam
- Contraindications to elective surgery in patients with liver disease:
  - Acute liver failure
  - AKI
  - Acute viral hepatitis
  - Alcoholic hepatitis
  - Cardiomyopathy
  - Hypoxemia
  - Severe coagulopathy (despite treatment)
  
- MELD score general risk (not lap chole):
  - <8 – mortality of 5%
  - 8-11 – mortality risk of 10%
  - 12-15 – mortality risk of 25%

$$\text{MELD} = 3.78 \times \log_e \text{ serum bilirubin (mg/dL)} + \\ 11.20 \times \log_e \text{ INR} + \\ 9.57 \times \log_e \text{ serum creatinine (mg/dL)} + \\ 6.43 \text{ (constant for liver disease etiology)}$$

NOTES:

If the patient has been dialyzed twice within the last 7 days, then the value for serum creatinine used should be 4.0

Any value less than one is given a value of 1 (i.e. if bilirubin is 0.8, a value of 1.0 is used) to prevent the occurrence of scores below 0 (the natural logarithm of 1 is 0, and any value below 1 would yield a negative result)

Clinical and Lab Criteria	Points*		
	1	2	3
Encephalopathy	None	Mild to moderate (grade 1 or 2)	Severe (grade 3 or 4)
Ascites	None	Mild to moderate (diuretic responsive)	Severe (diuretic refractory)
Bilirubin (mg/dL)	< 2	2-3	>3
Albumin (g/dL)	> 3.5	2.8-3.5	<2.8
Prothrombin time			
Seconds prolonged	<4	4-6	>6
International normalized ratio	<1.7	1.7-2.3	>2.3
<b>Child-Turcotte-Pugh Class obtained by adding score for each parameter (total points)</b>			
Class A = 5 to 6 points (least severe liver disease)			
Class B = 7 to 9 points (moderately severe liver disease)			
Class C = 10 to 15 points (most severe liver disease)			

- Why does it matter...
  - Increased risk of wound dehiscence and hernias
  - Impaired ventilation
  - Periop alcohol withdrawal and wernicke-korsakoff syndrome (give thiamine!)
  - Increased bleeding due to depleted vit K stores
  - Protein malnutrition

# Diabetic Patients

- Perioperative abnormalities due to surgical stress
  - peripheral insulin resistance
  - Increased hepatic glucose production
  - Impaired insulin production
- Additional organ system involvement
  - Cardiac
  - Gastroparesis
  - Immune response (inc risk of infection)
  - Vascular disease
- **MUST** maintain strict glylcemic control



# Additional Special Considerations

- Adrenally insufficient patients
  - Generally patients who get prednisone or equivalent at 20 mg/day for >3 wks should get stress dose steroids
  - Vitamin A
- Pregnant patients
  - Multiple physiologic and anatomic alterations; for another lecture...
  - Ideally operate during 2<sup>nd</sup> trimester
    - Lowest risk of precipitating spon. abortion or preterm labor
- Geriatric patients
  - Special attention to medications
  - Need established goals of care and family involvement

# Elements of the Op Note

- GI tract tubes
- Drains
- Respiratory tubes
- Foley
- Negative pressure wound dressing

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PH1000

DATE/TIME	PHYSICIAN'S POST-OP NOTE	DICTATED <input type="checkbox"/>
	PRE-OP DX:	
	POST-OP DX:	
	PROCEDURE:	
	SURGEON:	
	ASSISTANT:	
	ANESTHESIOLOGIST:	
	ANESTHESIA:	
	SPECIMENS:	<input type="checkbox"/> NONE
	BLOOD LOSS: _____ CC'S	<input type="checkbox"/> LESS THAN 15 CC'S
	COMPLICATIONS:	<input type="checkbox"/> NONE
	FINDINGS:	<input type="checkbox"/> PENDING PATH
	PHYSICIAN SIGNATURE: _____	ID# _____

PHYSICIAN'S POST-OP NOTE

# Post op Care

- Wound care
  - Primary closure
  - secondary closure
- Pain management
  - PO
  - IV
  - PCA
  - Epidural/spinal
- DVT prophylaxis
  - Periop risk of DVT = 25% if no ppx
  - Virchows triad
    - stasis, hypercoagulability, endothelial injury

# Post Op Complications

- Malignant hyperthermia
  - 1/14,000 children and 1/50,000 adults
  - Disruption of calcium metabolism
  - Symptoms:
    - Increased ETCO<sub>2</sub>
    - Temp (rise as much as 1-2 deg every 5 min)
    - Tachycardia, cyanosis, muscle rigidity
    - Compartment syndromes
    - Cardiac disturbances
  - Need early recognition (mortality now 5%, previously >70%)
  - Treatment:
    - d/c agent
    - IVF
    - Dantrolene (1 mg/kg)

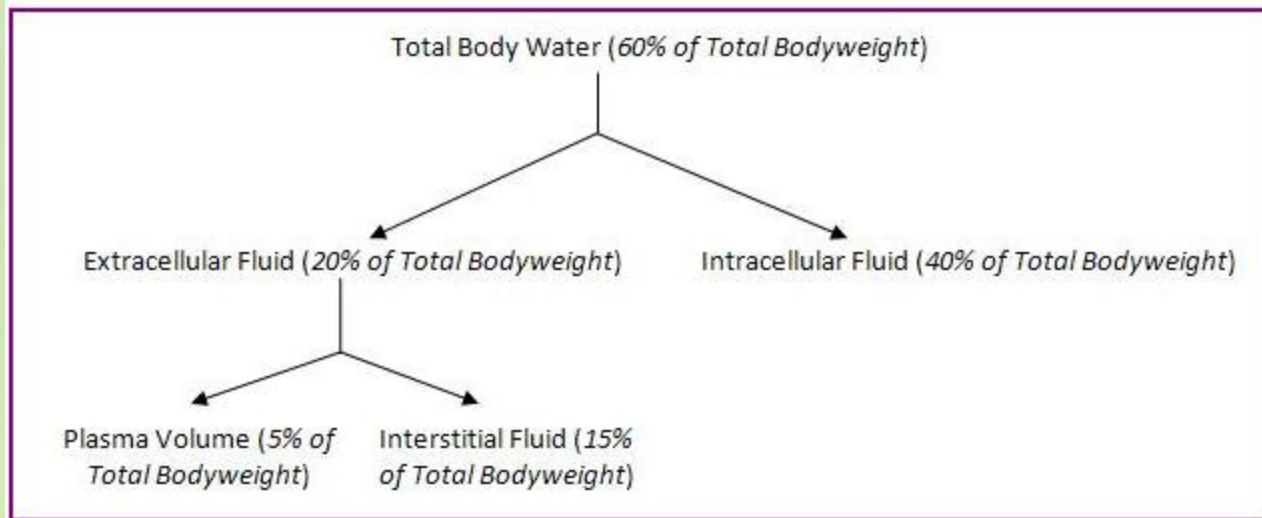
# Post Op Complications

- Atelectasis
  - Incentive spirometry
  - Chest physiotherapy
- Wound complications
  - Dehiscence
  - Evisceration
  - SSI (2-5% of all patients)
- Fever
  - Wind, water, wound, walking, wonder drug
  - Check out all lines/tubes
  - C.Diff

Chart 2 - Classification of wounds relative to the microbial content

Type of wound	Characteristic	Examples
Clean	Free from microorganisms	Heart surgery
Clean contaminated	Non-significant contamination and less than 6h elapsing until medical care	Biliary and gastric surgeries
Contaminated	Without local infection and more than 6h elapsing until medical care	Colon surgeries
Infected	Intense inflammatory reaction and frank infectious process	Appendicitis and colecistitis

# Total Body Water and Compartments



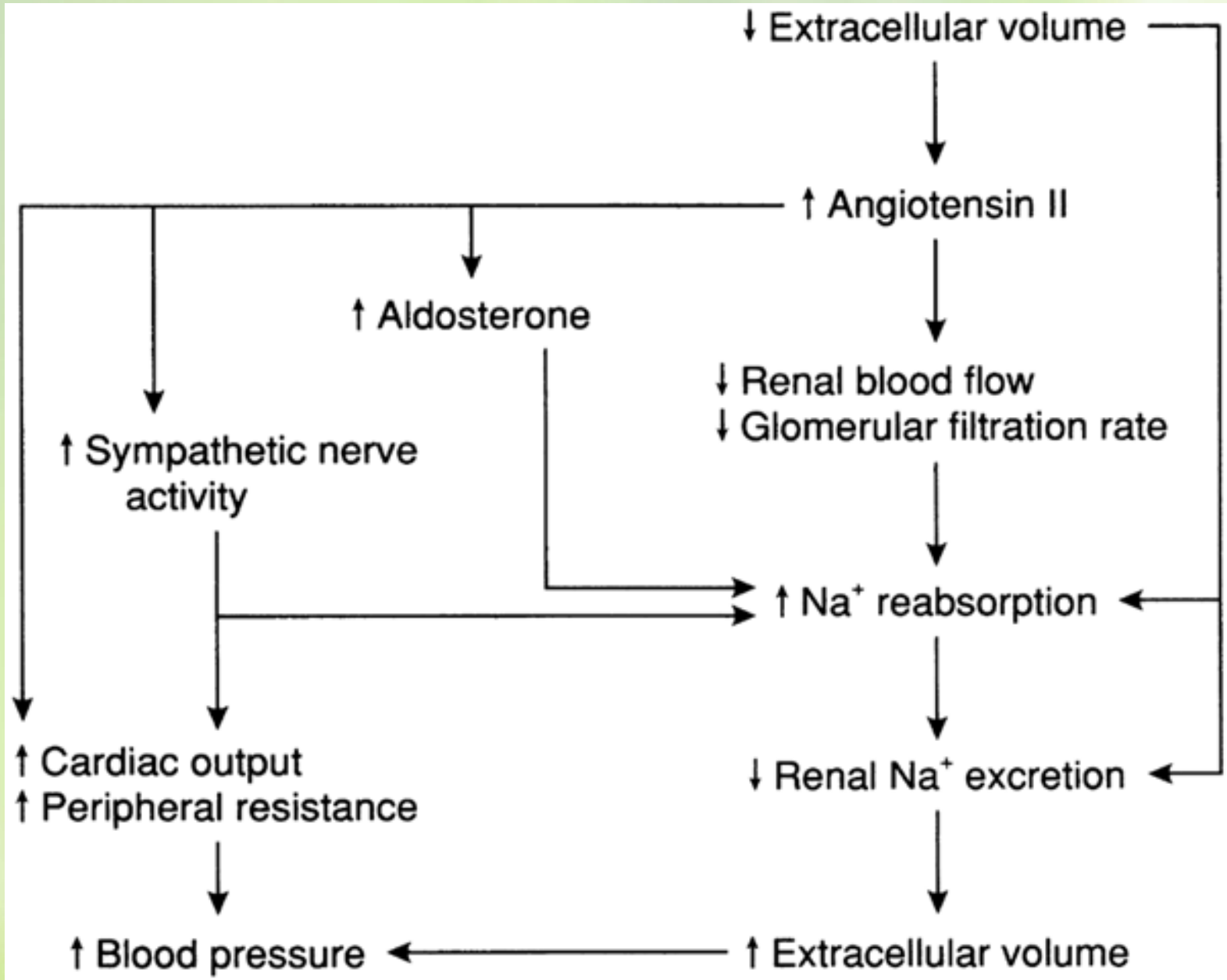
- Muscle mass = 70% water
- Fat mass = 10% water
- TBW = ~60% of weight (proportional to body composition)
  - Exceptions: elderly, morbidly obese

- Intracellular fluid
  - (+) potassium (high), magnesium
  - (-) phosphates, sulfates and proteins
- Extracellular fluid (plasma and interstitial space)
  - (+) sodium (high), potassium, calcium, magnesium
  - (-) chloride, bicarb, proteins, sulfates, organic acids
- Colloid osmotic pressure generated by protein gradient

# Sodium

- Osmolarity =  
 $2 \times [\text{Na}^+] + [\text{glucose}/18] + [\text{BUN}/2.8]$
- Normal osmolarity = 290 +/- 10 mOsmol/L
- Normal adult requirement 1-2 mEq/kg
- Excess excreted by kidneys
- Aldosterone: causes resorption of Na in exchange for K<sup>+</sup> and H<sup>+</sup> in distal tubule (RAAS)
- Antidiuretic hormone (ADH, vasopressin): reabsorption of water from cells in DCT via aquaporins





## ■ Hyponatremia

- HA, delirium, seizures, N/V
- Excessive free H<sub>2</sub>O or Na loss
- Tx: H<sub>2</sub>O restriction, then diuresis
- Correction rate should not exceed 0.5-1mEq/hr or central pontine myelinosis can occur
- **Na deficit = TBW x (140-Na)**

## ■ Hypernatremia

- Restlessness, irritability, ataxia, seizures
- Excessive free H<sub>2</sub>O loss
- Rapid correction risks cerebral edema and brain stem herniation
- **Total free H<sub>2</sub>O deficit = TBW x ([Na-140]/140)**

# Potassium

- 98% intracellular
- Normal level 3.5-5.0 mEq/L
- Normal daily requirements 0.5-0.8 mEq/kg
- Hypokalemia
  - Paralysis, ileus, EKG – flattened T waves, depressed ST segments, U waves
  - Redistribution to ICF or depletion
  - Tx: replace K, also replace Mag if low
- Hyperkalemia
  - Weakness, paresthesia, EKG – peaked T waves, flattened P waves
  - Decreased renal function, medications, crush injuries, massive blood transfusion
  - Tx: calcium gluconate, Na HCO<sub>3</sub>, 10 units regular insulin: 1amp D<sub>50</sub>W, kayexalate, dialysis

# Calcium

- 40% bound to plasma protein (albumin), 10% complexed, 50% ionized
- Ionized portion is physiologically active
- Normal levels 8-10.5 mg/dL, iCal 4.75-5.4 mg/dL
- Corrected total Ca =  $[0.8 \times (4.0 - \text{albumin})] + \text{total serum Ca}$
- Hypocalcemia (<8.0)
  - Perioral tingling, muscle cramps, paresthesia, hyperactive deep tendon reflexes, Chvostek's sign, Trousseau's sign, EKG – prolonged QT interval
  - Hypoparathyroidism, vit D deficiency, renal failure
  - Tx: replace if symptomatic, replace Mag
  - **Adjusted total Ca =  $[0.8 \times (\text{nl albumin} - \text{pt albumin})] + \text{Ca}$**
- Hypercalcemia
  - Muscle fatigue, weakness, personality d/o, confusion, depression, coma, N/V, abd pain
  - Hyperparathyroidism or malignancy
  - Tx: NSS @200-300cc/hr, lasix

# Magnesium

- Important cofactor for many enzymes
- 99% intracellular, bound to ATP
- Average intake 15-30 mEq
- Absorbed in jejunum and ileum
- Excreted by kidneys
- Hypomagnesemia
  - Similar to hypocalcemia, weakness, muscle fasciculations, N/V
  - Caused by dietary deficiency, GI losses, chronic alcoholism
- Hypermagnesemia
  - Loss of deep tendon reflexes, paralysis
  - Severe burns, crush injuries, renal insufficiency
  - Tx: volume, loop diuretic, dialysis

# Phosphorous

- 85% bound in bone
- Normal requirement 2-9 mg/kg
- Excretion controlled by PTH in kidneys
- Normal level 2.5-4.5 mg/dL
- Hypophosphatemia
  - Causes losses of K and mag
  - Inadequate uptake (malabsorption, GI losses, prolonged antacid use, vit D deficiency) or increased renal excretion (diuretics, SIADH, hypoparathyroidism)
  - Anorexia, dizziness, osteomalacia, severe cardiomyopathy, muscle weakness, visual defects, anemia, respiratory failure, leukocyte and erythrocyte failure
  - Treatment – identify cause, replace
- Hyperphosphatemia
  - Decreased renal excretion, increased absorption (excessive vitD, sarcoidosis)
  - No symptoms
  - Treatment: aluminum based antacids, diuretics, dialysis, does not always need to be treated

# Volume Depletion

- Causes: acute blood loss, EDF loss, total body water reductions
  - Vomiting, diarrhea, NGT, enteric fistulas
- Signs: change in heart rate, pulse pressure, oliguria, elevated Hct, urinary concentration
- Urine [Na] <20 mEq/L
- BUN/creat 20:1
- Urine osmolality >400
- $FeNa = (UNa/Pcr)/(PNa/Ucr) \times 100$ 
  - FeNa <1% prerenal azotemia
  - FeNa >2% renal injury

# Volume losses

Saliva	K	1L/d
Stomach	H, Cl	1-2L/d
Pancreas	HCO <sub>3</sub>	1L/d
Bile	HCO <sub>3</sub>	0.5-1L/d
Small intestine	HCO <sub>3</sub> , K	1-2L/d
Colon	K	

	Average daily volume (mL)	Minimal daily volume (mL)
<b>Sensible losses</b>		
Urinary	800–1,500	300
Intestinal/Stool	0–250	0
Sweat	0	0
<b>Insensible losses</b>		
Lungs and skin	600–900	600–900



# IVF

- **Maintenance fluid:**
  - 4-2-1 rule for cc/hr
  - 100-50-20 rule for cc/day

Solution	Electrolyte(mEq/L)					
	Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl <sup>-</sup>	HCO <sub>3</sub> <sup>-</sup>
0.9% NaCl	154	–	–	–	154	–
0.45% NaCl	77	–	–	–	77	–
Lactated Ringer's	130	4	3	–	109	28
3.0% NaCl	513	–	–	–	513	–

# ACID-BASE Balance

- $\text{pH} = \text{pK}_a + \log \frac{[\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]}$
- $[\text{H}^+] = 24 \times \text{PaCO}_2 / [\text{HCO}_3^-]$
- Normal pH = 7.4 +/- 0.05

# Metabolic Acidosis

- **Anion Gap =  $\text{Na} - (\text{Cl} + \text{HCO}_3)$** 
  - Normal is 12 +/- 2 mEq/L
- Decreased  $\text{HCO}_3$  content (consumption or loss) or decreased H excretion
- **MUDPILES** - Gap
  - methanol, uremia, DKA, paraldehydes, isoniazid, lactic acidosis ethylene glycol, salicylates
- **HARD UP** - Nongap
  - hyperalimentation, acetazolamide, renal tubular acidosis, diarrhea, ureteroenteric fistula, pancreaticoduodenal fistula
- Renal compensation – increase net excretion of H, takes 2-4 days
- Respiratory compensation – hyperventilation, takes 12-24 hrs  
 $\Delta\text{PCO}_2 = 1.2 \times \Delta\text{HCO}_3 \pm 2$

# Metabolic Alkalosis

- Loss of HCl, inhibited renal excretion of HCO<sub>3</sub>
- Vomiting/NGT suctioning results in
  - hypochloremic, hypokalemic, metabolic alkalosis, paradoxical aciduria
  - Volume depletion triggers aldosterone production
- Respiratory compensation – hypoventilation which is limited by hypoxia, least effective compensatory mechanism
$$\Delta\text{PCO}_2 = 0.7 \times \Delta\text{HCO}_3 \pm 5$$
- Tx: correct K and volume depletion with chloride containing solution

# Respiratory Acid-Base Disturbances

## ■ Alkalosis

- Hyperventilation secondary to hypoxia
- Compensatory mechanism – tissue buffering ie. RBCs, occurs in minutes
- Renal – decreasing net acid excretion, 2-3 days
- Tx: address underlying stimulus for hyperventilation, determine and correct hypoxemia

## ■ Acidosis

- Inadequate ventilation – CNS depression, COPD, airway obstruction
- Compensation mechanism – tissue buffering and increased renal excretion of acid
- Tx: correct underlying cause
- Chronic hypercapnia – complete correction of hypoxemia may further suppress respiratory drive and worsen respiratory acidosis

# Nutrition

- **Basic needs:**
  - **Kcals a person requires per day:**
    - 25-30 kcal/kg/day
  - **Fluid requirements per day:**
    - 30-40 mL/kg/day
  - **Protein requirements per day:**
    - **Normal**
      - 0.8-1.0 grams/kg/day
    - **Surgery**
      - 1.5-2.0 grams/kg/day
    - **Renal patients, pts with cirrhosis will have different requirements**

- Protein
  - 20-30% caloric intake
  - 4 kcal/g
  - Glutamine: primary fuel for small intestine enterocytes
- Lipids:
  - 30% daily caloric intake, 2-4% as essential fatty acids
  - 9 kcal/g
- Carbohydrates
  - 50-60% daily caloric intake
  - Need 120 g/day for CNS function
  - Glucose = 4 kcal/g
  - Dextrose = 3.4 kcal/g
  - Primary fuel source for brain, RBC, WBC

# Nutritional Assessment

- As always...H&P
  - Medications, BMI, type of surgery, recent changes in weight, appetite, (visceral proteins)
- Options:
  - Enteral
  - parenteral
- Always try to feed enterally!
  - Avoid mucosal compromise
  - Large role in immunologic function
  - Avoid bacterial translocation
  - Supported by multiple studies from burn patients to head injury pts



# Enteral Formulations

## LEHIGH VALLEY HOSPITAL — ENTERAL NUTRITION FORMULARY

Category	Isotonic	Isotonic With Fiber	High Protein With Fiber	Concentrated Calories	Calorie and Protein Dense	Very High Protein With Fiber	Renal (Dialysis)	Immunonutrition	Immunonutrition	
Product Name	Osmolite® 1 Cal	Jevity® 1 Cal	Jevity® 1.2 Cal	Ensure® Plus	TwoCal® HN	Promote® With Fiber	Nepro® with Carb Steady™	Impact® with Fiber	Impact® Glutamine	
Usage	Oral/Tube	Oral/Tube	Oral/Tube	Oral	Oral/Tube	Oral/Tube	Oral/Tube	Tube	Tube	
Nutrient Values per	1 L	1 L	1 L	1 L	1 L	1 L	1 L	1 L	1 L	
Cal/mL	1.06	1.06	1.2	1.5	2.0	1.0	1.8	1.0	1.3	
Carbohydrate % Cal	54.3	54.3	52.5	57.0	43.2	50.0	34.0	53	46	
Carbohydrate Source	Corn maltodextrin, Corn syrup solids	Corn maltodextrin, Corn syrup solids	Corn maltodextrin, Corn syrup solids, scFOS	Corn maltodextrin, Sugar, scFOS, Fibersol®	Corn syrup solids, Corn maltodextrin, Sugar, scFOS	Corn maltodextrin, Sugar	Corn syrup solids, Sugar, Maltitol syrup, Corn maltodextrin, scFOS	Maltodextrin	Maltodextrin	Milk
Protein % Cal	16.7	16.7	18.5	14.8	16.7	25.0	18.0	22	24	
Protein Source	Sodium and calcium caseinates, Soy protein isolate	Sodium and calcium caseinates, Soy protein isolate	Sodium and calcium caseinates, Soy protein isolate	Milk protein concentrate, Soy protein concentrate, Whey protein concentrate	Sodium and calcium caseinates	Sodium and calcium caseinates, Soy protein isolate	Calcium, magnesium, and sodium caseinates, Milk protein isolate	Sodium and calcium caseinates (Milk), L-Arginine	Wheat protein hydrolysate, Free amino acids, Sodium caseinates (Milk)	Crack
Fat % Cal	29.0	29.0	29.0	28.2	40.1	25.0	48.0	25	30	
Fat Source	Canola oil, Corn oil, MCTs, Soy lecithin	Canola oil, Corn oil, MCTs, Soy lecithin	Canola oil, Corn oil, MCTs, Soy lecithin	Canola oil, Corn oil, Soy lecithin	High oleic safflower oil, MCTs, Canola oil, Soy lecithin	Soy oil, MCTs, Safflower oil, Soy lecithin	High oleic safflower oil, Canola oil, Soy lecithin	Palm kernel oil, Refined menhaden oil, Sunflower oil	Palm kernel oil, Menhaden oil, Sunflower oil	Milk, coconut oil,
Carbohydrate (g)	143.9	154.7	169.4	211	218.5	138.3	166.8	140	150	
Protein (g)	44.3	44.3	55.5	54.9	83.5	62.5	81.0	56	78	
Fat (g)	34.7	34.7	39.3	48.1	90.5	28.2	96.0	28	43	
Nonprotein Cal/N Ratio	125:1	125:1	110:1	144:1	126:1	75:1	115:1	71:1	62:1	
Osmolality (mOsm/kg H <sub>2</sub> O)	300	300	450	680	725	380	585	375	630	
Na / K (mEq)	40.4 / 40.2	40.4 / 40.2	58.7 / 47.4	40.3 / 47.7	63.6 / 62.6	56.5 / 53.8	46.1 / 27.2	48 / 47	57 / 55	
Mg / P (mEq)	25.1 / 49.0	25.1 / 49.0	32.9 / 77.4	34.7 / 81.9	35.0 / 67.7	32.9 / 77.4	17.3 / 45.2	22.5† / 51.6†	33.3† / 77†	
mL to meet 100% RDIs*	1321	1321	1000	948	948	1000	948	1500	1000	
% Water	84	84	81	76	70	83	73	87	81	
Fiber (g)	—	14.4	18.0	12.7	5.0	14.4	15.6	10	10	
Indications for Use	Isotonic, low-residue, can be sole nutrition source	Isotonic, fiber-fortified, can be sole nutrition source	Concentrated calories, high protein, fiber-fortified, can be sole nutrition source	Volume limitation, interim sole-source feeding	Volume limitation, hyperosmolar, can be sole nutrition source	Very high protein, fiber-fortified, can be sole nutrition source	Renal failure (dialysis), volume limitation, hyperosmolar, can be sole nutrition source	High protein, fiber-fortified; protein bound and free arginine; can be sole nutrition source	Volume limitation, high protein, fiber-fortified; protein bound and free arginine; protein/peptide bound glutamine; can be sole nutrition source	Hep (≥ dr limit)

# Parenteral Nutrition

- IV infusion of dextrose, protein and lipids
- Need central access (TPN)
  - PPN exists but much less benefit
- Increased risk of hyperglycemia even in non-diabetics
- Basics:
  - Dextrose
    - start at 150-250 g/day and increase to goal based on pt's weight and metabolic state
    - Monitor blood glucose for 24-48 hours (maintain 80-150)
  - Protein in surgical patients goal of 1.5-2.0 g/kg (adjust for renal/liver failure)
  - Lipids
    - Should not exceed 0.1 g/kg/hr
    - Can cause immunosuppression (omega-6 FA) and hyperlipidemia
    - Monitor triglycerides (maintain <400)
  - Add MVI and minerals

# Assessing Nutritional Effectiveness

- Nitrogen Balance:

- Nitrogen intake - Nitrogen output:

- $(\text{g protein or AA intake}/6.25) - (\text{UUN} + 4)$

- UUN = urine urea nitrogen

- Positive balance of 2-4 g/day indicates anabolic state

- Altered by hepatic failure, diuresis, altered creatinine clearance, fistulas, etc

- Serum proteins

- Prealbumin and transferrin

- Not always accurate for malnutrition - down regulated with severe illness due to liver upregulating acute phase proteins)

# Refeeding Syndrome

- fluid, micronutrient, electrolyte and vitamin imbalances that occurs within first few hours-days after initiating nutrient infusion in chronically malnourished patients
- Usually see hypokalemia, hypophosphatemia, hypomagnesia
- Results in:
  - Hemolytic anemia
  - Respiratory distress
  - Paresthesias
  - tetany
  - Cardiac arrhythmias
- Treatment: limit dextrose to 100-150 g/day, monitor lytes

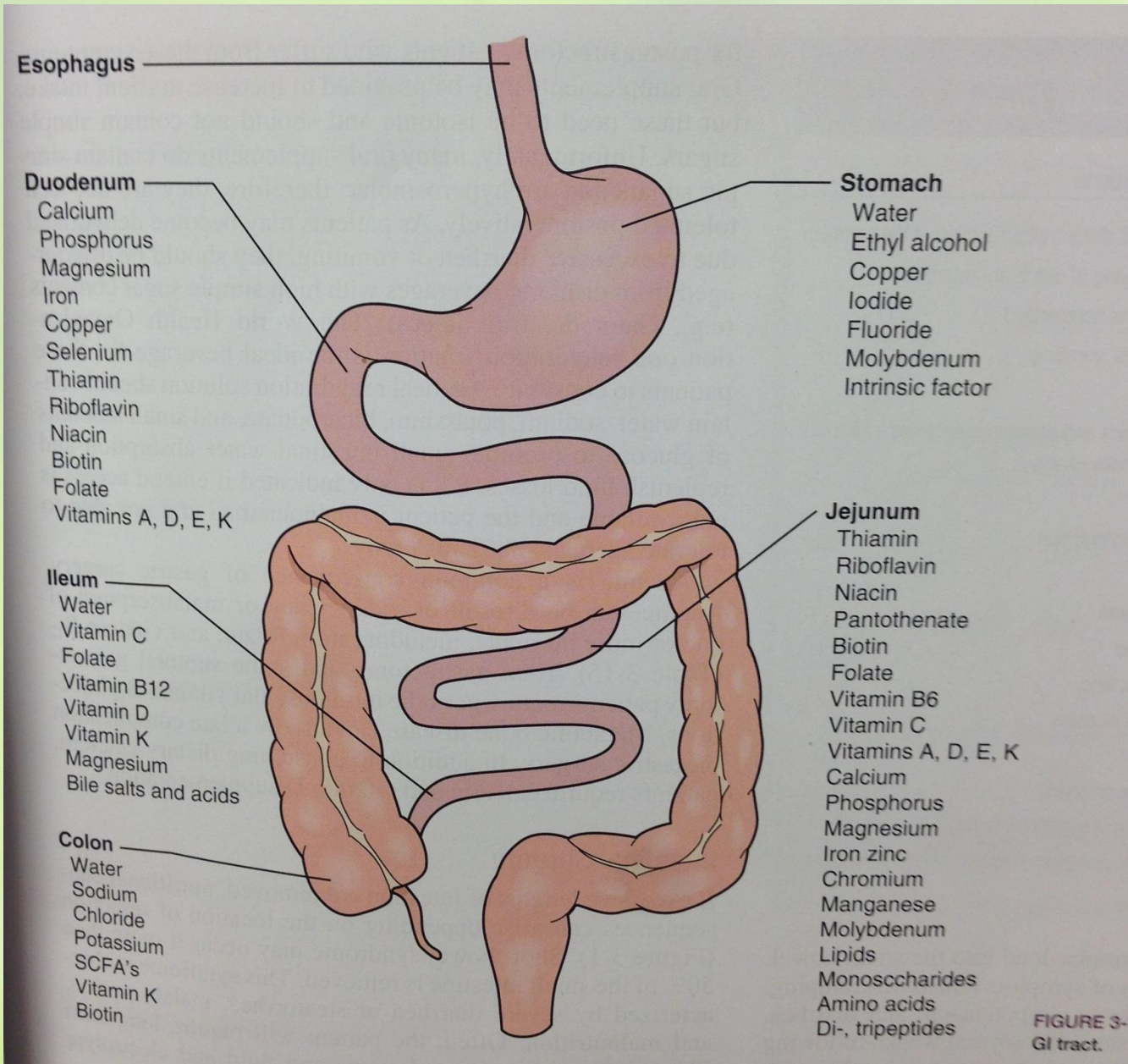


FIGURE 3-1.  
GI tract.

# Special Nutritional Considerations

- Consider feeding tube early in treatment course
  - Head and Neck surgery
    - Often have alcohol or tobacco use
  - Esophageal surgery
- Gastric surgery
  - dumping syndrome
  - Anemia
- Intestinal surgery
  - Short bowel syndrome
  - Absorption issues
- Pancreaticoduodenectomy
  - Delayed gastric emptying
  - Weight loss
  - Diabetes
  - Malabsorption from exocrine insufficiency
- Ileostomy and colostomy
  - Monitor output

# Review Questions





# Questions?

