

Clinical Skills Review for Pharmacists

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Objectives

- Describe and interpret key elements of a physical examination that assess efficacy & safety of pharmacotherapy
- For common laboratory values, interpret relative to the normal range and describe their effect on and how they are affected by pharmacotherapy
- Use the results of other diagnostic tests (including imaging studies such as Xrays) to optimize pharmacotherapy

Outline

- Physical Examination
 - Vital Signs (Temp, HR, BP, RR) & general appearance
 - Review of Systems
- Laboratory values
 - Chemistry, Hematology, Coagulation, Liver function
 - Endocrine, Critical Care
 - Serum Drug Levels, Infectious Diseases
- Other diagnostic tests
 - Imaging: Ultrasound, Xrays, MRI, CT
 - Special Tests (EKG, PFT, Endoscopy)

Physical Examination

- Vital Signs

Value	"Normal"
Temperature	36.8° +/- 0.4° C
Heart Rate	60-80 beats per minute
Blood Pressure	SBP 90 – 120 mm Hg DBP 60 – 80 mm Hg
Respiratory Rate	12 – 20 breaths per minute

Temperature 36.8° C

- Hypothermia (< 36° C)
 - Environmental
 - Shock & hypo-perfusion
- Hyperthermia (> 38.3° single, > 38° sustained)
 - Environmental
 - Heat stroke & shock
 - Fever
 - Infection
 - Malignancy, drug effects
 - Auto-immune, hypersensitivity,

Heart Rate

60 - 80 beats per minute

- Bradycardia (< 60 bpm)
 - Endogenous
 - Arrhythmias
 - Exogenous
 - Pharmacological (Beta-blockers, CCB's)
- Tachycardia (> 100 bpm)
 - Fever
 - Hypotension (maintain cardiac output)
 - Metabolic (hyperthyroid)

Blood Pressure

SBP 90-120 / DBP 60-80 mm Hg

- Hypotension (SBP < 90)
 - Cardiogenic
 - Mechanical (MI, Heart failure)
 - Electrochemical (Arrhythmias)
 - Vascular
 - Volume
 - Bleeding, Dehydration or 3rd spacing (oncotic)
 - Systemic Vascular Resistance (SVR)
 - Sepsis (vasodilator)
 - Pharmacological (vasodilators, anti-hypertensives)

Blood Pressure

SBP 90-120 / DBP 60-80 mm Hg

- Hypertension
 - Acute Crisis (DBP > 120)
 - Urgency if no target organ damage
 - Emergency if CNS, heart, kidney damage
 - Drugs, volume (renal failure), poor adherence
 - Chronic
 - Cardiac, renal, retinal et al damage
 - Goals based on co-morbidities
 - Prehypertension 120-139 / 80-90
 - Stage I 140-159 / 90-99
 - Stage II ≥ 160 / ≥ 100

Respiratory Rate

12 - 20 breaths per minute

- Bradypnea (< 10)
 - Narcotics
- Tachypnea (> 25)
 - Respiratory distress
 - Asthma exacerbation, pneumonia

General Appearance

- Well vs Ill
- Development, nourishment (anorexic)
- Cyanotic, Jaundice, Anemic
- Weight & Height
 - Body Mass Index (BMI)
 - Normal 18-25
 - Overweight (25-30)
 - Obese (> 30)

General Appearance

- Skin & Mucus Membranes
 - Rashes
 - Appearance, Distribution, Itching?
 - Turgid & Moist?
 - Hydration status
 - Integrity
 - Cuts, damage

Physical Examination

- Head, Eyes, Ears, Nose & Throat
 - General appearance
 - s/s Infection
 - Eyes
 - Pupils response, ataxia & nystagmus
 - Retina for damage from diabetes, hypertension

Physical Examination (2)

- Cardiac Exam
 - Rate and Rhythm
 - Arrhythmias like atrial fibrillation
 - Heart Sounds
 - Murmurs (endocarditis)
 - Clicks (mechanical heart valve)
 - S1 et al...

Physical Exam (3)

- Pulmonary
 - Breath sounds
 - Crackles (Edema, Infection)
 - Wheezes (Asthma)
 - Dullness (infiltrates or masses)

Physical Examination (4)

- Abdomen
 - General including skin, size
 - Described by quadrant
 - Upper vs lower, left vs right
 - Ascites et al stigmata of liver failure
 - Liver & spleen
 - Rebound, Guarding or Tenderness
 - Infection, inflammation

Physical Exam (5)

- Genital, Urethral, & Rectal
 - Lesions, Discharge, Pain
 - Urination
 - Urgency, frequency, dysurea; color etc.
 - Blood in stool
 - Bright red or black & tarry
 - Prostate exam

Neurological & Musculo-skeletal

- Cranial Nerves & symmetry
 - Nerve damage & stroke
- General & specific strength & tone
- Reflexes & neuropathies (diabetes)
- Edema
 - Heart, liver failure

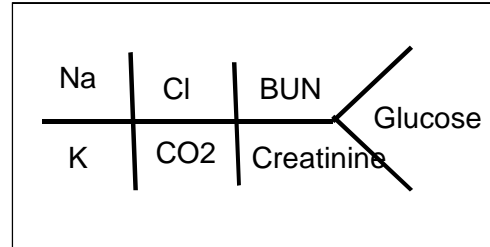
Laboratory

- Chemistries (Electrolytes et al)
 - Na, K, Cl, CO₂; BUN, SCr., Glucose, Mg, Ca, Phos;
- Hematology
 - WBC (diff), Hb/HCT (MCV), Plts
- Liver & Coagulation
 - ALT, AST, AP, GGT; Bili; Albumin
 - aPTT, PT/INR, aXa

Laboratory

- Endocrine TSH, Serum Cortisol
- Inflammation ESR, CRP
- Cardiology Troponins (MI), BNP
- Infectious Diseases
 - General (CSF glucose, protein)
 - Staining & morphology
 - Culture
 - Sensitivity
 - PCR, Latex agglutination

Basic Metabolic Profile



Sodium

134 – 145 mmol/L

- Major extracellular cation; water/volume
- Hyponatremia
 - Dilution by free water (edema)
- Hypernatremia
 - Depends...

Potassium

3.3 – 4.9 mmol/L

- Major Intracellular cation (90% inside)
- Hypokalemia (Keep above 4 if on digoxin)
 - Diuretic use
 - Treatment = Replacement
- Hyperkalemia
 - Cause (too much in, not enough out, drugs)
 - EKG (peaked T waves)
 - Treatment to remove, shift back into cell

Chloride & CO2 (bicarbonate)

- Negative ions
- Acid / base disturbances
- Ion Gap ($\text{Na} - (\text{Cl} + \text{HCO}_3) = \text{Anion Gap}$)
 - Ketoacidosis
 - Toxicity (Methanol, Asprin).

BUN & S. Cr

2.9 – 8.9 mmol/L & 18 – 88 mcmol/L

- Renal function / clearance
- S.Cr. accumulates with GFR (delayed)
- Estimates renal function drug dosing
 - Cockcroft Gault equation (1976)
 - $[(140 - \text{Age}) * \text{IBW kg}] / (72 * \text{SCr mg/dL})$, * 0.85 if female
 - Normal is 85 – 135 mL/min/1.73 m²
 - < 60 = problem, adjust medications

Glucose

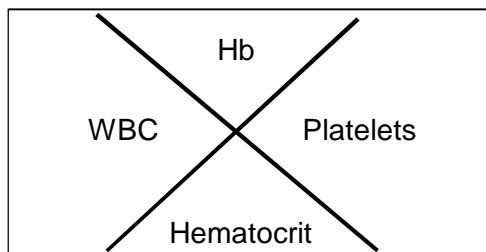
3.6 – 6 mmol/L fasting

- Major energy source
- Diabetes – elevated due to lack of (type I) or resistance to (type II) insulin
- Fasting > 7 or fed > 11 c/w diabetes
- Acute by finger stick blood sugars
- Chronic (3 months) measured by glycosylated hemoglobin A1C

Other electrolytes

- Calcium (2.2 – 2.55 mmol/L)
 - Protein bound, correct for hypoalbuminemia
 - Hypocalcemia
 - parathyroid or vitamin D problem
 - Hypercalcemia
 - Malignancy
- Phosphate (0.8 – 1.6 mmol/L)
 - Energy & breathing
 - Hypo in malnutrition
 - Hyper in renal failure; precipitate with calcium

Hematology



White Blood Cells

4-10 x 10³ cells/mm³

- 50-65% Neutrophils
Polymorphonucleated (PMN)
- 25-35% Lymphocytes
- 0-5% Bands (immature neutrophils)
- 0-3% Eosinophils

White Blood Cells

- Neutrophils
 - High in acute bacterial infections
 - Bands > 5% = severe infection
 - Low in immunosuppression (neutropenia)
- Leukocytes
 - High in malignancies (leukemias)
 - Low in human immunodeficiency syndrome
- Eosinophils
 - Elevated in allergy, parasitic infection & cancer

Red Blood Cells

	Males	Females
Hemoglobin	13.8 – 17.2 g/dL	12.1 – 15.1 g/dL
Hematocrit	40.7 – 50.3 %	36.1 – 44.3 %

Low in anemia

- Increased destruction
 - Bleeding, hemolytic (drugs!)
- Decreased production
 - Mean Corpuscular Volume
 - < 80 = microcytic = Iron and / or EPO
 - > 100 = macrocytic = B12 or folate

Platelets

140 – 440 x 10³ cells/mm³

- Initial steps in clotting
- High in acute illness
- Low often drug effect
 - Heparin induced thrombocytopenia (HIT)
 - Others

Liver “Function” Tests

- Hepatitis / inflammation
 - Aminotransferases = specific for liver (esp ALT)
 - Alanine (ALT) 7-53 IU/L
 - Aspartate (AST) 11-47 IU/L
 - Gama glutamyl transferase (GGT) 0-30 IU/L
 - Alkaline phosphatase 38-126 IU/L

Liver “function” test & Pancreas

- Gall bladder (cholestasis)
 - Bilirubin (Total, direct & indirect)
- Albumin (3.5 – 5 g/dL)
 - Protein, major source oncotic pressure
 - Binds many drugs (phenytoin)
- Pancreas
 - Amylase (22-115 IU/L)

Coagulation

- Activated partial thromboplastin time (aPTT)
 - Range calibrated to anti Xa activity (by machine)
 - Depends on indication / intensity
- Prothrombin Time (PT) is converted to the International Normalized Ratio (INR).
- Anti factor ten a (aXa) activity
 - clotting factor specific, range depends on drug, indication

Lab	Drug	Normal	Therapeutic
aPTT	Heparin	25-40 seconds	75 – 100 but varies
INR	Warfarin	1-1.4	2-3 (2.5-3.5)
aXa	Heparin, LMWH		0.4 – 0.7 for heparin

Misc

- Cardiology
 - Troponins
 - Elevated in myocardial infarctions
 - Creatine Kinase – MB fraction
- Inflammation (non-specific)
 - Erythrocyte Sedimentation Rate (ESR)
 - Normal < 20-30 mm/h
 - C-reactive protein (CRP)
 - Normal < 8 mg/L

Misc

- Endocrine
 - Thyroid Stimulating Hormone
 - High if not enough replacement being given
 - Serum Cortisol
 - Measure absolute value & response to cosyntropin stimulation test to assess adrenal function
 - Cholesterol
 - Total < 200 mg/dL (5.18 mmol/L) desirable
 - Low density < 70 to < 130 mg/dL desirable per risk
 - High density > 35 desirable
 - Triglycerides < 160 mg/dL fasting desirable

Misc

- Critical Care
 - D – Dimer (< 250 ng/mL)
 - Thrombosis, Disseminated Intravascular Coagulopathy
 - B-type Natriuretic Peptide
 - Heart failure (vs pulmonary disease)
- Urine Analysis
 - Fluids & A/B: pH, Specific Gravity, Osmolality
 - Diabetes: Glucose, Ketones, Protein
 - Infection: Nitrites, Leukocyte Esterase, WBC

Serum Drug Levels

Drug	Levels (trough)
Digoxin Monitor Clinically: HR, s/s of toxicity;	Afib: 0.8 – 1.5 ng/mL CHF: 0.5–1 ng/mL Need to keep pts serum potassium >4
Carbamazepine	Monotherapy 8-12 Combination therapy 4-8 mcg/mL
Phenytoin	10-20 mcg/mL corrected for albumin Corrected = (Measured)/[(Alb x 0.2*) + 0.1] *use 0.1 in patients with renal failure
Valproic Acid Questionable clinical utility	50-100 mcg/mL

Serum Drug Levels

- Vancomycin
 - Troughs 30 minutes before dose
 - 10 – 20 mg/L in general
 - 15 – 20 mg/L for severe
 - meningitis, pneumonia +/- endocarditis, osteomyelitis
 - Peaks of questionable value
 - Keep below 45 or so...

Serum Drug Levels

- Gentamicin & Tobramycin
 - Troughs 30 minutes before dose
 - < 2 (I prefer 1 or less) to avoid nephrotoxicity
 - Peaks 30 minutes after end of infusion
 - 4-10 depending on infection
 - UTI 4-6 mg/L
 - Bacteremia 6-8 mg/L
 - Pneumonia 8-10 mg/L

Infectious Disease

- Fluid properties (WBC et al)
- Gram Stain
- Culture
- Susceptibility
- Serology (antigens, antibodies)

Imaging

- Ultrasound
 - Fluids & soft tissue
 - Abscesses, pregnancy, DVT
- X Rays
 - Bones, harder tissue
- CT/MRI
 - Details

Other testing

- EKG
 - Heart rate & rhythm
- Echocardiogram
 - Heart function (ejection fraction)
- Pulmonary Function Tests
 - O₂ saturation > 85%
 - Forced Expiratory Volume in 1 second (FEV₁)
 - Peak Expiratory Flow Rate (Peak Flow)