PART II CLINICAL SCIENCES · BOARD REVIEW

Study Guide 1

This guide covers general diagnosis: the history and physical examination in Chapter 1, then the laboratory and special studies in Chapter 2. You will learn which history items predict serious disease, how to take and classify a blood pressure, how to read the chest, heart and abdomen, and how to turn a lab value into a decision. Work one chapter at a time. Read the "what to know" paragraphs, study the diagram and tables, then try each worked case with the steps covered. Finish each chapter with its ten board-style items. The cram sheet at the end puts the numbers in one place.

WHAT THIS GUIDE COVERS

- Chapter 1 · the comprehensive history, OPQRST, red flags, SOAP notes, blood pressure technique and classification, orthostatic vitals, pulse, respiration, BMI, the eye, ear, throat and neck exam, Weber and Rinne, the chest and heart exam, murmurs, peripheral vascular signs, and the abdominal, hernia, rectal and scrotal exam.
- Chapter 2 · urinalysis and casts, the CBC and anemia workup, coagulation, ESR, electrolytes and the anion gap, diabetes criteria, liver, lipid, bone and cardiac labs, thyroid tests, serology and HLA-B27, sensitivity, specificity and predictive values, ECG, spirometry, DXA and nerve conduction and EMG.

CHAPTER 1

Case History, Vital Signs and the Physical Examination

Read it in full: **Chapter 1 in the textbook**. Practice it: **Practice exam 1** and the **flashcards**.

What to know

Most diagnoses are made, or strongly suspected, before any test is ordered. The history points to the answer and the examination confirms or refutes it. In a chiropractic office these skills separate a mechanical back pain from an aneurysm, a kidney infection or a metastasis.

Take the history in a fixed order: identifying data and source, **chief complaint** in the patient's own words, history of present illness, past medical history, family history, personal and social history, and the review of systems. Characterize every symptom with **OPQRST** (onset, provocation and palliation, quality, region and radiation, severity, timing) or OLDCARTS. Record **pertinent negatives**: "no saddle numbness, no urinary retention" matters as much in a back pain note as anything the patient reports. Smoking is recorded in pack years (packs per day times years).

A **red flag** is a history or exam feature linked to serious disease. Red flags do not prove disease, and many are weak alone, but they change the plan. Screen every new spinal patient for cancer, infection, fracture, cauda equina syndrome and vascular emergency, and document it. The strongest single predictor of spinal malignancy is a **prior history of cancer**. In cauda equina syndrome the most common finding is urinary retention with overflow incontinence, and the classic sensory sign is saddle anesthesia. Suspected cervical artery dissection (the 5 Ds and 3 Ns) means no manipulation and emergency referral.

Interview with open questions first, then closed questions to test ideas. Avoid leading and compound questions. Use a trained interpreter, not a relative. Document in **SOAP** format (subjective, objective, assessment, plan). Correct an error with a single line, date and initials. Never erase or backdate. Document informed consent before treatment.

Blood pressure technique: rested 5 minutes, back supported, feet flat, arm bare and supported at heart level, a cuff whose bladder wraps about 80% of the arm and is about 40% of its width. Estimate systolic by palpation first, then inflate 20 to 30 mm Hg higher to avoid an **auscultatory gap**. Deflate at 2 to 3 mm Hg per second. Systolic is **Korotkoff phase I**, diastolic is **phase V** in adults (phase IV when sounds go to zero in children and pregnancy). A cuff too small, an arm below heart level, talking, crossed legs or a full bladder all read high.

Classification: normal under 120 and under 80; elevated 120 to 129 and under 80; stage 1 is 130 to 139 or 80 to 89; stage 2 is 140 or more or 90 or more; crisis is over 180 and/or over 120. Crisis with target organ damage is an emergency. Pulse pressure is systolic minus diastolic; mean arterial pressure is about diastolic plus one third of the pulse pressure. Wide pulse pressure suggests aortic regurgitation, hyperthyroidism, anemia or stiff arteries. Pulsus paradoxus (an inspiratory fall over

10 mm Hg) is classic for tamponade. An arm difference over about 10 to 15 mm Hg suggests subclavian stenosis, dissection or coarctation.

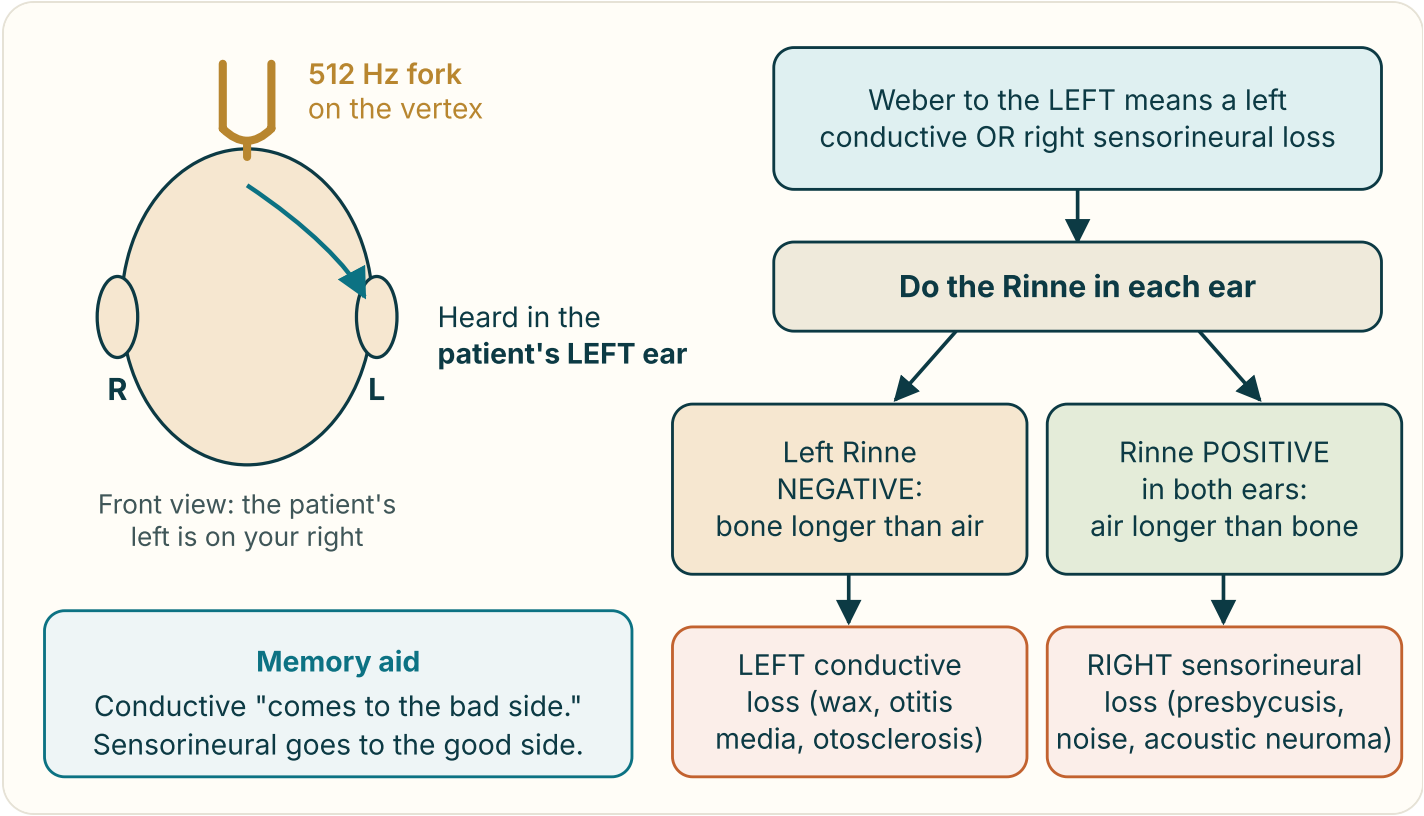
Other vitals: pulse 60 to 100, respiration 12 to 20, fever 38.0°C (100.4°F) or more, SpO_2 95 to 100%. **Orthostatic hypotension** is a fall of 20 systolic or 10 diastolic within 3 minutes of standing; a brisk rate rise points to volume loss, no rate rise to autonomic failure or beta blockers. BMI is kg divided by m^2; 18.5 to 24.9 is normal and 30 or more is obesity. Height loss over about 4 cm suggests compression fractures. Kussmaul breathing means metabolic acidosis; Cheyne Stokes means heart failure or bilateral cerebral damage.

Head and neck: Snellen at 20 feet (20/40 means you read at 20 feet what a normal eye reads at 40). A chiasm lesion gives **bitemporal hemianopia**. A Marcus Gunn pupil dilates when the light swings onto it. Papilledema means raised intracranial pressure. AV nicking and flame hemorrhages mean hypertension. **Weber** goes to the bad ear in conductive loss and the good ear in sensorineural loss; **Rinne** reverses (bone greater than air) only in conductive loss. The uvula pulls away from a CN X lesion; the tongue deviates toward a CN XII lesion. A hard, fixed or supraclavicular node is suspicious, and the left supraclavicular **Virchow node** signals abdominal cancer. JVP over 3 to 4 cm above the sternal angle is elevated.

Chest: tactile fremitus is increased over consolidation and decreased over effusion, pneumothorax and emphysema. Consolidation is dull with bronchial sounds and egophony; effusion is stony dull with absent sounds; pneumothorax is hyperresonant. The trachea moves away from a large effusion or tension pneumothorax and toward atelectasis. Chest expansion under about 2.5 cm is classic for ankylosing spondylitis.

Heart: the PMI sits in the fifth intercostal space at the left midclavicular line. S3 means a volume loaded ventricle (normal under about 40), S4 a stiff one. Fixed splitting of S2 means an atrial septal defect; paradoxical splitting means a delayed A2. Aortic stenosis is a harsh midsystolic murmur at the right second interspace radiating to the carotids; mitral regurgitation is holosystolic at the apex radiating to the axilla. Diastolic murmurs are always pathologic, and a thrill means grade IV or louder. Valsalva and standing make hypertrophic cardiomyopathy louder. An ABI of 0.90 or less defines peripheral arterial disease.

Abdomen: inspect, auscultate, percuss, palpate, in that order. A palpable spleen is abnormal; an aorta over about 3 cm or expansile pulsation suggests aneurysm. Murphy sign means cholecystitis; McBurney, Rovsing, psoas and obturator signs mean appendicitis. Indirect inguinal hernias enter lateral to the inferior epigastric vessels; direct hernias push through Hesselbach triangle medial to them. On rectal exam, cancer is hard and nodular, BPH smooth and rubbery, and reduced tone with saddle anesthesia suggests cauda equina syndrome. **Testicular torsion** (high horizontal testis, absent cremasteric reflex) is an emergency.



Weber first, Rinne decides. The Weber only tells you which side the sound goes to. A negative Rinne (bone longer than air) in that ear proves a conductive loss there; a positive Rinne in both ears means the other ear has a sensorineural loss.

LOCK THESE IN

- History order: CC, HPI, PMH, FH, SH, ROS. Characterize with OPQRST and record pertinent negatives.
- Prior cancer is the strongest predictor of spinal malignancy. Urinary retention is the most common cauda equina finding; saddle anesthesia is the classic sensory sign.
- Systolic is Korotkoff phase I, diastolic phase V. A cuff too small reads falsely high.
- Stage 1 starts at 130 or 80, stage 2 at 140 or 90, crisis over 180 and/or 120. Only one number needs to fall in a stage.
- Orthostatic hypotension: a fall of 20 systolic or 10 diastolic within 3 minutes of standing.
- Weber goes to the bad ear in conductive loss; a negative Rinne (BC greater than AC) confirms conductive loss.
- Consolidation: dull, increased fremitus, bronchial sounds. Effusion: stony dull, decreased fremitus and sounds. Pneumothorax: hyperresonant.
- S3 volume overload, S4 stiff ventricle, fixed split S2 ASD, diastolic murmur always abnormal, thrill means grade IV or more.

Blood pressure categories (adults)

Category	Systolic (mm Hg)	Diastolic (mm Hg)
Normal	Under 120	and under 80
Elevated	120 to 129	and under 80
Stage 1 hypertension	130 to 139	or 80 to 89
Stage 2 hypertension	140 or higher	or 90 or higher
Hypertensive crisis	Over 180	and/or over 120; with organ damage it is an emergency

Chest findings by condition

Condition	Percussion	Fremitus	Breath sounds	Trachea
Consolidation	Dull	Increased	Bronchial; egophony	Midline
Pleural effusion	Stony dull	Decreased	Decreased or absent	Midline or away if large
Pneumothorax	Hyperresonant	Decreased or absent	Decreased or absent	Away if tension
Emphysema	Hyperresonant	Decreased	Decreased, long expiration	Midline
Atelectasis	Dull	Decreased or absent	Decreased or absent	Toward the lesion

Vital sign and exam numbers

Item	Value	Note
Pulse	60 to 100 per minute	Irregularly irregular means atrial fibrillation
Respiration	12 to 20 per minute	Count without telling the patient
Fever	38.0°C (100.4°F) or more	Rectal about 0.5°C higher, axillary 0.5°C lower
SpO_2	95 to 100%	Falsely normal in carbon monoxide poisoning
BMI	18.5 to 24.9 normal; 30 or more obesity	kg ÷ m^2
JVP	Over 3 to 4 cm above the sternal angle is high	Head of table at 30 to 45 degrees
ABI	1.0 to 1.4 normal; 0.90 or less PAD	Over 1.4 means calcified vessels
Murmur grade	IV/VI or louder has a thrill	Diastolic murmurs are always pathologic

Worked cases

WORKED CASE 1 · CLASSIFY A BLOOD PRESSURE AND FIND MAP

Two seated readings on two visits average 150/90 mm Hg. Classify it and find the pulse pressure and mean arterial pressure.

STEP 1 · FIND THE STAGE

Systolic 150 is 140 or higher, so it already meets **stage 2**. Diastolic 90 also meets stage 2. Only one value has to qualify.

STEP 2 · PULSE PRESSURE

150 − 90 = **60 mm Hg**, right at the upper edge of normal.

STEP 3 · MEAN ARTERIAL PRESSURE

MAP ≈ diastolic + one third of pulse pressure = 90 + 60 ÷ 3 = 90 + 20 = **110 mm Hg**.

STEP 4 · PLAN

Stage 2 without crisis values or organ damage symptoms: refer to the primary care provider for management. Incidental hypertension is one of the most useful referrals a chiropractor makes.

WORKED CASE 2 · WEBER AND RINNE

The Weber lateralizes to the left ear. On the left, bone conduction lasts longer than air conduction. On the right, air conduction is longer. Where is the problem?

STEP 1 · READ THE WEBER

Sound in the left ear means either a left conductive loss or a right sensorineural loss.

STEP 2 · READ THE LEFT RINNE

Bone greater than air on the left is a **negative Rinne**, which only happens with conductive loss.

STEP 3 · READ THE RIGHT RINNE

Air greater than bone on the right is normal (positive).

STEP 4 · CONCLUDE

Left conductive hearing loss, for example wax, otitis media or otosclerosis.

IF THE LEFT RINNE WERE POSITIVE

Then the Weber pull to the left would mean the right ear has a sensorineural loss. In an adult with one sided sensorineural loss and tinnitus, refer to exclude an acoustic neuroma.

WORKED CASE 3 · RED FLAGS IN A LOW BACK HISTORY

A 68 year old man with 45 pack years, hypertension and claudication reports constant, deep low back pain that does not change with position. How do you read this?

STEP 1 · MECHANICAL OR NOT

Pain unaffected by position or movement is **nonmechanical**. That alone sends you to the abdomen and the vascular history.

STEP 2 · MATCH THE PATTERN

Older male smoker with known vascular disease and steady deep back pain fits an **abdominal aortic aneurysm**.

STEP 3 · EXAMINE

Palpate the aorta. Over about 3 cm or an expansile pulsation that pushes the hands apart supports an aneurysm. Listen for bruits.

STEP 4 · ACT

If the pain is acute, tearing or pulsatile, this is an emergency referral. Do not manipulate.

WORKED CASE 4 · ORTHOSTATIC VITALS

Supine: 128/80, pulse 72. After 3 minutes standing: 104/74, pulse 98, and the patient feels light headed. Interpret.

STEP 1 · FIND THE DROPS

Systolic falls 128 − 104 = 24 mm Hg. Diastolic falls 80 − 74 = 6 mm Hg.

STEP 2 · APPLY THE RULE

A systolic fall of 20 or more within 3 minutes is **orthostatic hypotension**, even though diastolic fell only 6.

STEP 3 · READ THE PULSE

Pulse rose 26 beats per minute. A brisk rise with the drop points to **volume depletion** (bleeding, vomiting, diuretics). No rise would point to autonomic failure or a beta blocker.

CHECK

A rise of 30 or more with no fall in pressure would instead define postural orthostatic tachycardia syndrome.

TRAPS PEOPLE FALL INTO

- **Calling 134/78 "elevated."** Systolic 130 to 139 is stage 1 even when diastolic is normal. The higher category wins.
- **Recording diastolic at muffling in an adult.** Adults use phase V, disappearance. Phase IV is for children and pregnancy when sounds go to zero.

- **Blaming a large arm on the patient.** A cuff that is too small reads falsely high. Change the cuff, not the diagnosis.
- **Reading the Weber alone.** A Weber to the left fits a left conductive or a right sensorineural loss. The Rinne decides.
- **Mixing up consolidation and effusion.** Both are dull. Fremitus and breath sounds go up in consolidation and down in effusion.
- **Treating an S3 as always abnormal.** It is normal in children, young adults, athletes and pregnancy. After about 40 it suggests heart failure.
- **Relying on the Homans sign.** It is neither sensitive nor specific. Use a Wells score with D dimer or duplex ultrasound.
- **Calling epididymitis torsion.** Torsion has an absent cremasteric reflex and no relief on elevation. Epididymitis keeps the reflex and eases with elevation.

Chapter 1 self-test · ten items

1. A 59 year old woman with low back pain had breast cancer treated 7 years ago. Which history item most strongly predicts spinal malignancy?

A. No relief after 3 weeks of care
B. Her age over 50 years
C. The prior breast cancer
D. Pain that wakes her at night

C. The prior breast cancer Prior cancer is the strongest single predictor. Age, night pain and failure to improve are red flags but weaker.

2. A seated reading averages 128/84 mm Hg over two visits. How is it classified?

A. Stage 2 hypertension
B. Stage 1 hypertension
C. Normal blood pressure
D. Elevated blood pressure

B. Stage 1 hypertension Diastolic 80 to 89 meets stage 1, and only one value has to fall in the range. Elevated requires diastolic under 80.

3. During blood pressure measurement, which error produces a falsely LOW reading?

A. The arm held above heart level
B. A cuff bladder that is too small
C. The patient talking during the reading
D. The legs crossed at the knees

A. The arm held above heart level An arm above heart level reads low. A small cuff, talking and crossed legs all raise the reading.

4. A patient's pressure falls from 132/84 supine to 110/80 at 3 minutes of standing with no change in heart rate. Best explanation?

A. Simple dehydration from vomiting
B. Postural orthostatic tachycardia
C. Acute gastrointestinal blood loss
D. Autonomic failure or beta blockade

D. Autonomic failure or beta blockade A 22 mm Hg systolic fall is orthostatic hypotension. Without a compensatory rate rise, think autonomic failure (diabetic neuropathy, Parkinson disease) or beta blockers.

5. The Weber lateralizes to the right ear, and the right Rinne shows air conduction longer than bone. The left Rinne is also normal. What is most likely?

A. Right sensorineural hearing loss
B. Right conductive hearing loss
C. Left sensorineural hearing loss
D. Left conductive hearing loss

C. Left sensorineural hearing loss Right conductive loss would reverse the right Rinne. With both Rinne tests normal, a Weber to the right means the left ear has the sensorineural loss.

6. Over the left lower chest there is stony dullness, absent fremitus and absent breath sounds, with the trachea shifted to the right. What is present?

A. A large left pleural effusion
B. Left lower lobe pneumonia
C. Left lower lobe atelectasis
D. Emphysema of the left lung

A. A large left pleural effusion Stony dullness with decreased fremitus and sounds is effusion, and a large one pushes the trachea away. Atelectasis pulls it toward the lesion.

7. A 21 year old runner has a soft early diastolic sound at the apex heard with the bell. Best interpretation?

A. An opening snap of mitral stenosis
B. A normal S3 in a young athlete
C. Heart failure until proven otherwise
D. An S4 from a stiff ventricle

B. A normal S3 in a young athlete An S3 is normal in children, young adults, athletes and pregnancy. After about 40 it suggests heart failure.

8. A harsh midsystolic murmur gets louder when the patient stands and strains (Valsalva) and softer with squatting. Which lesion fits?

A. Chronic mitral regurgitation
B. Valvular aortic stenosis
C. Ventricular septal defect
D. Hypertrophic cardiomyopathy

D. Hypertrophic cardiomyopathy Reducing preload makes most murmurs softer but makes hypertrophic cardiomyopathy louder, since the outflow obstruction worsens.

9. Deep pressure in the left lower quadrant causes pain in the right lower quadrant. Name the sign and the condition.

A. Rovsing sign, appendicitis
B. Murphy sign, cholecystitis
C. Carnett sign, wall pain
D. Kehr sign, splenic injury

A. Rovsing sign, appendicitis Rovsing sign is right lower quadrant pain on left sided pressure, a sign of appendicitis with peritoneal irritation.

10. A 14 year old has sudden severe left scrotal pain with vomiting. The left testis rides high with a horizontal lie and no cremasteric reflex. Next step?

A. Antibiotics for epididymitis
B. Scrotal elevation and recheck
C. Transillumination at follow up
D. Emergency surgical referral

D. Emergency surgical referral This is testicular torsion. Salvage falls sharply after about 6 hours, so it is a surgical emergency.

CHAPTER 2

Laboratory Interpretation and Special Studies

Read it in full: **Chapter 2 in the textbook**. Practice it: **Practice exam 1** and the **flashcards**.

What to know

Tests are tools for questions the history has already raised. Order a test when its result will change management, and read every value against the patient in front of you.

Urinalysis has three parts. Physical: color, clarity, odor and specific gravity (about 1.005 to 1.030); a specific gravity fixed at about 1.010 means chronic kidney disease. Dipstick: protein (mainly albumin, so it misses Bence Jones light chains), glucose (spills above a blood level of about 180 mg/dL), ketones, blood, bilirubin, urobilinogen, nitrite (specific for gram negative bacteria) and leukocyte esterase (pyuria). A blood positive dipstick with no red cells on microscopy means hemoglobin or **myoglobin** (rhabdomyolysis). Microscopy: casts form in the distal tubule, so they localize disease to the kidney. Red cell casts mean glomerulonephritis, white cell casts pyelonephritis, muddy brown granular casts acute tubular necrosis, fatty casts nephrotic syndrome.

Anemia is a sign, not a diagnosis. Sort by MCV first (under 80 micro, 80 to 100 normo, over 100 macro), then the reticulocyte count (high means loss or hemolysis, low means production failure). Iron deficiency has low ferritin, high TIBC and a high RDW; ferritin is the most specific test. In a man or a postmenopausal woman, iron deficiency means gastrointestinal blood loss until proven otherwise. Anemia of chronic disease has normal or high ferritin and low TIBC. Thalassemia trait has microcytosis with a normal or high red cell count (Mentzer index under 13). B12 deficiency raises methylmalonic acid and homocysteine and can damage the dorsal columns; folate deficiency raises homocysteine only. Hemolysis raises LDH and indirect bilirubin and lowers haptoglobin.

White cells: neutrophils rise in bacterial infection (a left shift means more bands), lymphocytes in viral infection, eosinophils in allergy and parasites. Blasts in the blood mean urgent referral. Platelets under about 50,000 raise surgical bleeding risk, under 10,000 to 20,000 spontaneous

bleeding. **PT/INR** tracks the extrinsic pathway and warfarin (factor VII goes first); **aPTT** tracks the intrinsic pathway, heparin and hemophilia. D dimer is sensitive but not specific, a rule out test. The **ESR** is slow and nonspecific; a rough upper limit is age ÷ 2 for men and (age + 10) ÷ 2 for women. Over 100 mm/h suggests myeloma, giant cell arteritis, polymyalgia rheumatica or osteomyelitis.

Chemistry: sodium 135 to 145, potassium 3.5 to 5.0, bicarbonate 22 to 28, creatinine about 0.6 to 1.2, fasting glucose 70 to 99. The **anion gap** is Na − (Cl + HCO_3), normally 8 to 12; a high gap acidosis means ketoacidosis, lactic acidosis, uremia or toxins. A BUN to creatinine ratio over 20 suggests a prerenal cause or upper GI bleeding. Diabetes: fasting glucose 126 or more, 2 hour OGTT 200 or more, HbA1c 6.5% or more, or random 200 or more with symptoms. Prediabetes is 100 to 125 fasting or HbA1c 5.7 to 6.4%. CKD is eGFR under 60 for more than 3 months.

Liver: ALT is liver specific; an AST to ALT ratio over 2 suggests alcohol. A cholestatic pattern raises ALP and GGT. An **isolated high ALP with normal GGT points to bone**. Lipids: LDL by Friedewald is total − HDL − TG ÷ 5 (invalid when TG is over about 400). Bone labs: primary hyperparathyroidism has high calcium, low phosphorus and high PTH; osteomalacia low phosphorus and high ALP; Paget disease a very high ALP with normal calcium; myeloma high calcium with a normal ALP and a cold bone scan; **osteoporosis has normal labs**. Correct calcium for low albumin: measured + 0.8 × (4.0 − albumin).

Troponin rises at about 3 to 4 hours, peaks at 24 to 48 hours and stays up 7 to 10 days; CK-MB clears in 2 to 3 days, so it helps spot reinfarction. A BNP under about 100 makes heart failure unlikely. TSH is the best single thyroid screen; high TSH with low free T4 is primary hypothyroidism.

Serology: **CRP** rises within hours and falls quickly, so it tracks activity better than ESR. RF is sensitive but nonspecific for rheumatoid arthritis; **anti-CCP** is about 95% specific. A negative ANA nearly excludes lupus; anti-dsDNA and anti-Smith are specific; antihistone means drug induced lupus; anticentromere means limited scleroderma (CREST). HLA-B27 is in about 90% of white patients with ankylosing spondylitis but also in 6 to 8% of the healthy population, so it helps only when the clinical picture is strong. Gout crystals are needle shaped and negatively

birefringent; urate may be normal during an attack. PSA is prostate specific, not cancer specific. Anti-HBs alone means vaccination; IgM anti-HBc means acute hepatitis B.

Test logic: a reference range covers 95% of healthy people, so 20 tests on a healthy person give at least one "abnormal" about 64% of the time. **Sensitivity** (TP over all with disease) and **specificity** (TN over all without disease) belong to the test. **Predictive values** depend on prevalence: as prevalence falls, PPV falls and NPV rises. SnNout: a sensitive test, negative, rules out. SpPin: a specific test, positive, rules in.

Special studies: on ECG paper a small box is 0.04 s and a large box 0.20 s; rate is 300 ÷ large boxes; PR is 0.12 to 0.20 s and QRS under 0.12 s. Obstructive spirometry lowers FEV_1/FVC below 0.70; restrictive disease (including ankylosing spondylitis) lowers TLC. DXA T score of −2.5 or lower is osteoporosis; use Z scores in premenopausal women, men under 50 and children. In radiculopathy the **SNAP is normal** (the lesion is proximal to the dorsal root ganglion) and paraspinal EMG is abnormal; denervation takes about 3 weeks to appear on EMG.

Screening 1,000 people: prevalence 5%, sensitivity 90%, specificity 90%

	Disease present 50 people	**Disease absent** 950 people	
Test positive 140 test positive	TP **45**	FP **95**	→ PPV = 45 ÷ 140 = 32%
Test negative 860 test negative	FN **5**	TN **855**	→ NPV = 855 ÷ 860 = 99.4%
	↓ **Sensitivity** 45 ÷ 50 = 90%	↓ **Specificity** 855 ÷ 950 = 90%	Read down the columns

Columns belong to the test and stay fixed. Rows (PPV, NPV) shift with prevalence: at 50% prevalence the same test gives a PPV of 90%.

Read down for sensitivity and specificity, across for predictive values. With a rare disease, even a good test gives more false positives (95) than true positives (45), so the PPV is only 32% while the NPV is excellent.

LOCK THESE IN

- Casts localize to the kidney: red cell casts glomerulonephritis, white cell casts pyelonephritis, muddy brown casts ATN, fatty casts nephrotic syndrome.
- Blood on the dipstick with no red cells means hemoglobin or myoglobin. The dipstick misses Bence Jones protein.
- Low ferritin with high TIBC is iron deficiency; in men and postmenopausal women look for GI bleeding.
- PT/INR: warfarin, extrinsic, factor VII. aPTT: heparin, hemophilia, intrinsic.
- Anion gap = Na − (Cl + HCO_3), normal 8 to 12. Diabetes: fasting 126, OGTT 200, HbA1c 6.5%.
- Osteoporosis has normal labs. Paget: very high ALP. Myeloma: high calcium, normal ALP.
- Sensitivity and specificity belong to the test; PPV and NPV move with prevalence. SnNout, SpPin.
- Radiculopathy: normal SNAP, abnormal paraspinal EMG; EMG denervation needs about 3 weeks.

Formulas and ranges to know

Item	Formula or range	Use
Anion gap	Na − (Cl + HCO_3); normal 8 to 12	High gap: ketoacidosis, lactate, uremia, toxins
Corrected calcium	Ca + 0.8 × (4.0 − albumin)	Low albumin hides true calcium
Friedewald LDL	Total − HDL − TG ÷ 5	Invalid when TG is over about 400
ESR upper limit	Men age ÷ 2; women (age + 10) ÷ 2	mm/h, rough guide
Mentzer index	MCV ÷ RBC count	Under 13 favors thalassemia trait
Sensitivity	TP ÷ (TP + FN)	Rule out when negative
Specificity	TN ÷ (TN + FP)	Rule in when positive
PPV, NPV	TP ÷ (TP + FP); TN ÷ (TN + FN)	Change with prevalence
LR+, LR−	Sens ÷ (1 − spec); (1 − sens) ÷ spec	Over 10 or under 0.1 is strong
ECG rate	300 ÷ large boxes, or 1,500 ÷ small boxes	Irregular: QRS in 6 s × 10

Bone and mineral lab patterns

Condition	Calcium	Phosphorus	ALP	PTH
Primary hyperparathyroidism	High	Low	Normal or high	High
Secondary hyperparathyroidism (CKD)	Low or normal	High	High	High
Malignancy (PTHrP)	High	Low	Normal or high	Low
Osteomalacia	Low or normal	Low	High	High
Paget disease	Normal	Normal	Very high	Normal
Multiple myeloma	High	Normal	Normal	Low
Osteoporosis	Normal	Normal	Normal	Normal

Worked cases

WORKED CASE 1 · PREDICTIVE VALUE AND PREVALENCE

A test has 90% sensitivity and 90% specificity. It is used to screen 1,000 people in whom the disease prevalence is 5%. Find the PPV and NPV.

STEP 1 · SPLIT THE GROUP

5% of 1,000 = 50 with disease; 950 without.

STEP 2 · APPLY SENSITIVITY

TP = 0.90 × 50 = 45; FN = 5.

STEP 3 · APPLY SPECIFICITY

TN = 0.90 × 950 = 855; FP = 95.

STEP 4 · PREDICTIVE VALUES

PPV = 45 ÷ (45 + 95) = 45 ÷ 140 = **32%**. NPV = 855 ÷ (855 + 5) = 855 ÷ 860 = **99.4%**.

CHANGE THE POPULATION

At 50% prevalence the same test gives a PPV of 90%. Sensitivity and specificity did not move; the predictive values did. Likelihood ratios here are LR+ = 0.9 ÷ 0.1 = 9 and LR− = 0.1 ÷ 0.9 = 0.11.

WORKED CASE 2 · ANION GAP AND CORRECTED CALCIUM

A patient has Na 138, Cl 100, HCO_3 14 mEq/L. Separately, an older patient has calcium 8.0 mg/dL with albumin 2.5 g/dL. Interpret both.

STEP 1 · ANION GAP

138 − (100 + 14) = 138 − 114 = **24**, well above 8 to 12.

STEP 2 · READ IT

A low bicarbonate with a high gap is a **high anion gap metabolic acidosis**: think ketoacidosis, lactic acidosis, uremia or methanol, ethylene glycol or salicylates.

STEP 3 · CORRECT THE CALCIUM

8.0 + 0.8 × (4.0 − 2.5) = 8.0 + 0.8 × 1.5 = 8.0 + 1.2 = **9.2 mg/dL**.

STEP 4 · READ IT

The corrected value is normal (8.5 to 10.5). The low measured calcium came from low albumin, not a true calcium problem.

WORKED CASE 3 · A LAB PICTURE THAT POINTS TO MYELOMA

A 70 year old man with three months of thoracolumbar pain has hemoglobin 10.2 g/dL, ESR 98 mm/h, calcium 11.4 mg/dL, raised total protein and a normal ALP. The urine dipstick is negative for protein.

STEP 1 · CHECK THE ESR

Upper limit for a 70 year old man is about 70 ÷ 2 = 35 mm/h. 98 is nearly three times that.

STEP 2 · ADD THE PIECES

Anemia + very high ESR + hypercalcemia + high protein in an older adult with back pain: **multiple myeloma** until proven otherwise.

STEP 3 · EXPLAIN THE NORMAL ALP

Myeloma lesions are purely lytic, so there is no osteoblastic response. ALP stays normal and the bone scan can be cold.

STEP 4 · EXPLAIN THE DIPSTICK

The dipstick detects albumin and misses Bence Jones light chains, so a negative result does not rule it out.

STEP 5 · ACT

Refer for serum and urine protein electrophoresis and hematologic evaluation. No spinal manipulation until cleared.

WORKED CASE 4 · FRIEDEWALD LDL AND AN ECG RATE

A lipid panel shows total cholesterol 240, HDL 45 and triglycerides 200 mg/dL. On a regular ECG strip there are 4 large boxes between R waves.

STEP 1 · LDL

240 − 45 − 200 ÷ 5 = 240 − 45 − 40 = **155 mg/dL**, in the borderline high range (130 to 159).

STEP 2 · VALIDITY

Triglycerides are 200, under about 400, so the formula is valid.

STEP 3 · HEART RATE

300 ÷ 4 = **75 per minute**. Check: 4 large boxes = 20 small boxes, and 1,500 ÷ 20 = 75.

TRAPS PEOPLE FALL INTO

- **Trusting a negative dipstick for protein in suspected myeloma.** The dipstick misses light chains. Order protein electrophoresis.
- **Calling a blood positive dipstick hematuria.** Check the microscopy. No red cells means hemoglobin or myoglobin.
- **Reassuring a 60 year old man with iron deficiency.** Iron deficiency in a man or postmenopausal woman is GI blood loss until proven otherwise. Refer.
- **Treating a positive ANA as lupus.** Low titers are common in healthy people. A negative ANA rules lupus out; anti-dsDNA and anti-Smith rule it in.
- **Ordering HLA-B27 for every back pain.** It is carried by 6 to 8% of healthy white people. Use it only when inflammatory back pain makes the diagnosis plausible.
- **Thinking sensitivity changes with prevalence.** Sensitivity and specificity stay put. PPV falls and NPV rises as prevalence falls.
- **Expecting abnormal labs in osteoporosis.** Calcium, phosphorus and ALP are normal. Abnormal values mean look for another disease.
- **Ordering EMG on day 5 of a radiculopathy.** Fibrillations take about 2 to 3 weeks to appear, so EMG is usually deferred about 3 weeks.

Chapter 2 self-test · ten items

1. A patient with fever, flank pain and costovertebral angle tenderness has white cell casts on urinalysis. What do the casts establish?

A. Acute tubular necrosis is present
B. Infection is limited to the bladder
C. Infection involves the kidney itself
D. The bleeding is from the glomerulus

C. Infection involves the kidney itself Casts form in the distal tubule, so white cell casts place the infection in the kidney: pyelonephritis rather than cystitis.

2. Two days into a heat wave, a roofer who collapsed at work has dark urine. The blood pad reads 3+ yet the sediment shows no erythrocytes. Most likely cause?

A. A contaminated urine sample
B. Myoglobin from muscle breakdown
C. Hematuria from a kidney stone
D. Glomerular bleeding with casts

B. Myoglobin from muscle breakdown A positive blood dipstick without red cells means hemoglobin or myoglobin. After extreme exertion, think rhabdomyolysis and check CK.

3. A 62 year old man has MCV 72 fL, ferritin 6 ng/mL and high TIBC. What is the most important next step?

A. Order hemoglobin electrophoresis
B. Order B12 and folate levels now
C. Start iron and recheck in a year
D. Refer for gastrointestinal workup

D. Refer for gastrointestinal workup This is iron deficiency. In an adult man it means GI blood loss (colon cancer, ulcer, NSAIDs) until proven otherwise.

4. A vegan patient has macrocytic anemia, hypersegmented neutrophils, loss of vibration sense and raised methylmalonic acid. What is the deficiency?

A. Vitamin B12
B. Iron
C. Folic acid
D. Vitamin B6

A. Vitamin B12 Methylmalonic acid rises in B12 but not folate deficiency, and only B12 deficiency damages the dorsal columns.

5. Which test is the first to prolong when warfarin therapy begins?

A. Bleeding time
B. Platelet count
C. PT and INR
D. aPTT

C. PT and INR Factor VII has the shortest half life, so the PT (extrinsic pathway) prolongs first. aPTT is used to follow unfractionated heparin.

6. A patient has Na 140, Cl 104 and HCO_3 12 mEq/L. What is the anion gap and its meaning?

A. 36, a normal gap acidosis
B. 12, a normal gap
C. 16, a metabolic alkalosis
D. 24, a high gap acidosis

D. 24, a high gap acidosis 140 − (104 + 12) = 24, above 8 to 12, with low bicarbonate: high anion gap metabolic acidosis.

7. An older adult with bone pain and a bowing tibia has a very high ALP, normal calcium, normal phosphorus and normal GGT. Most likely diagnosis?

A. Paget disease of bone
B. Multiple myeloma
C. Postmenopausal osteoporosis
D. Primary hyperparathyroidism

A. Paget disease of bone An isolated, strikingly high ALP with normal GGT (bone source) and normal calcium is Paget disease.

8. Which antibody is the most specific marker for rheumatoid arthritis?

A. HLA-B27
B. Anti-CCP
C. Rheumatoid factor
D. Antinuclear antibody

B. Anti-CCP Anti-CCP is about 95% specific and predicts erosive disease. RF is common in other conditions and in healthy older adults.

9. A screening test moves from a specialty clinic to a general population with much lower prevalence. What happens?

A. Sensitivity falls and the PPV rises
B. Specificity rises and the NPV falls
C. The PPV and NPV both stay the same
D. PPV falls; sensitivity is unchanged

D. PPV falls; sensitivity is unchanged Sensitivity and specificity are properties of the test. Lower prevalence lowers the PPV and raises the NPV.

10. A patient has numbness in the L5 dermatome. The superficial peroneal SNAP is normal and the lumbar paraspinal EMG shows fibrillations. Where is the lesion?

A. The common peroneal nerve
B. The sciatic nerve trunk
C. The L5 spinal nerve root
D. The lumbosacral plexus

C. The L5 spinal nerve root A normal SNAP means the lesion is proximal to the dorsal root ganglion, and abnormal paraspinals place it at the root (posterior ramus).

ONE PAGE

Cram sheet

Everything from chapters 1 and 2 in one place. Cover the right columns and see if you can rebuild each row.

Numbers to know

Item	Value	Note
BP stages	Stage 1 130 to 139 or 80 to 89; stage 2 140 or 90	Crisis over 180 and/or 120
Korotkoff	Phase I systolic; phase V diastolic	Phase IV in children and pregnancy
Orthostatic	Fall of 20 systolic or 10 diastolic	Within 3 minutes of standing
Vitals	Pulse 60 to 100; RR 12 to 20; fever 38.0°C	SpO_2 95 to 100%
BMI	18.5 to 24.9 normal; 30 or more obesity	kg ÷ m^2
ABI	0.90 or less PAD; over 1.4 calcified	Under about 0.4 critical ischemia
Electrolytes	Na 135 to 145; K 3.5 to 5.0; HCO_3 22 to 28	Anion gap 8 to 12
Diabetes	Fasting 126; OGTT 200; HbA1c 6.5%	Prediabetes 100 to 125 or 5.7 to 6.4%
Troponin	Up at 3 to 4 h, peak 24 to 48 h, lasts 7 to 10 days	CK-MB clears in 2 to 3 days
DXA	T score −2.5 or lower is osteoporosis	−1.0 to −2.5 is low bone mass
ECG	Small box 0.04 s; large 0.20 s; PR 0.12 to 0.20 s	QRS under 0.12 s
EMG timing	Fibrillations after about 2 to 3 weeks	Defer EMG about 3 weeks

Rules that decide questions

Topic	The rule
Malignancy	Prior cancer is the strongest predictor of spinal malignancy.
Cauda equina	Urinary retention most common; saddle anesthesia classic; emergency referral.
Hearing	Conductive "comes to the bad side" on Weber; negative Rinne only in conductive loss.
Chest	Consolidation dull with more fremitus; effusion stony dull with less.
Murmurs	AS to the carotids, MR to the axilla; diastolic always abnormal; thrill is grade IV or more.
Abdomen	Inspect, auscultate, percuss, palpate; Murphy cholecystitis; Rovsing, psoas, obturator appendicitis.
Casts	RBC glomerulonephritis; WBC pyelonephritis; muddy brown ATN; fatty nephrotic.
Anemia	MCV first, then reticulocytes; low ferritin is iron deficiency.
Bone labs	Osteoporosis normal; Paget very high ALP; myeloma high Ca, normal ALP.
Test logic	SnNout, SpPin; predictive values move with prevalence.
Radiculopathy	Normal SNAP, abnormal paraspinal EMG.

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