

Impaired Liver Function - Part Three

The next patient is a 51-year-old female with chief complaint of eczema, hot flashes, severe muscle and joint pain, and vulvodynia.

Marker	Value	Functional Range	Lab Range
Glucose	96	75 - 90	65 - 99
Hemoglobin A1c	5.2	4.4 - 5.4	4.8 - 5.6
Uric Acid	4.5	3.2 - 5.5	2.5 - 7.1
BUN	30	13 - 18	6 - 24
Creatinine	0.75	0.85 - 1.1	0.57 - 1
Sodium	139	135 - 140	134 - 144
Potassium	4.2	4.0 - 4.5	3.5 - 5.2
Chloride	98	100 - 106	97 - 108
CO2	28	25 - 30	18 - 29
Calcium	10.0	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.5	3.5 - 4.0	2.5 - 4.5
Magnesium	2.1	2.0 - 2.6	1.6 - 2.6
Protein, total	7.1	6.9 - 7.4	6.0 - 8.5
Albumin	4.8	4.0 - 5.0	3.5 - 5.5
Globulin	2.3	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.1	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.4	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	84	42 - 107	39 - 117
LDH	170	140 - 180	119 - 226
AST	85	10 - 30	0 - 40
ALT	123	10 - 22	0 - 32
GGT	19	0 - 28	0 - 60
TIBC	318	250 - 350	250 - 450
UIBC	226	150 - 375	150 - 375
Iron	92	85 - 135	35 - 155
Iron saturation	29	15 - 45	15 - 55
Ferritin	95	MW: 30 - 150	15 - 150
Cholesterol, total	144	150 - 250	100 - 199
Triglycerides	52	50 - 100	0 - 149
HDL	71	55 - 85	> 39
LDL	63	0 - 175	0 - 99
T. Chol / HDL Ratio	2.0	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.73	< 2	< 3.8
TSH	0.126	0.5 - 2.5	0.450 - 4.500
T4, total	3.7	6.0 - 12	4.5 - 12.0
T3 Uptake	28	28 - 35	24 - 39
T3, Total	84	100 - 180	71 - 180
Vitamin D, 25-hydroxy	42.6	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
WBC	4.8	5.0 – 8.0	3.4 - 10.8
RBC	4.35	4.4 – 4.9	3.77 - 5.28
Hemoglobin	14.0	13.5 - 14.5	11.1 - 15.9
Hematocrit	43.6	37 - 44	34.0 - 46.6
MCV	100	85 – 92	79 - 97
MCH	32.2	27.7 – 32.0	26.6 - 33.0
MCHC	32.1	32 – 35	31.5 - 35.7
RDW	13.2	11.5 – 15.0	12.3 - 15.4
Platelets	248	150 – 415	150 - 379
Neutrophils	49	40 – 60	
Lymphocytes	36	25 – 40	
Monocytes	12	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	1	0.0 – 3.0	
Additional Tests:			
CRP-hs	1.16	< 1.0	0.00 - 3.00
Homocysteine	7.1	< 9.0	0.0 - 15.0
Vitamin B-12	>1999	450 – 2000	211 - 946
Copper	134		72 - 166
Zinc	114		56 - 134
Zinc / Copper Ratio	0.85	> 0.85	
Serum Methylmalonic Acid (MMA)	123	0 - 325	0 - 378

Her AST and ALT were both out of the lab range. Her AST was 85, and her ALT was 123. Alkaline phosphatase and GGT are normal, but she had a history of elevations of both markers, and LDH is normal. Fasting glucose is slightly high at 96, but A1c and follow-up fasting blood glucose testing as well as post-meal blood sugar testing were normal. Her copper and zinc are normal. Follow-up ceruloplasmin and urine copper were normal. Ferritin is a bit high, but other iron markers are normal. CRP is slightly high, and a follow-up with soluble transferrin receptor and A1-acid glycoprotein indicated no evidence of iron overload.

She didn't have significant risk factors for hepatitis, but I screened her anyway because of how common hepatitis is as a cause of elevated AST and ALT, the fact that she didn't have iron overload or any other obvious cause, and also because her enzymes were higher than I typically see for nonalcoholic fatty liver disease.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
HBV/HCV (Profile VIII)					
HBsAg Screen	Negative			Negative	01
Hep Be Ag	Negative			Negative	02
Hep B Core Ab, IgM	Negative			Negative	01
Hep B Core Ab, Tot	Negative			Negative	01
Hep Be Ab	Negative			Negative	02
Hep B Surface Ab, Qual	Reactive				01
	Non Reactive: Inconsistent with immunity, less than 10 mIU/mL Reactive: Consistent with immunity, greater than 9.9 mIU/mL				
HCV Ab	0.1			s/co ratio 0.0 - 0.9	01
Comment:	Non reactive HCV antibody screen is consistent with no HCV infection, unless recent infection is suspected or other evidence exists to indicate HCV infection.				
A1A, Quant+Genotype(Rfx Pheno)					
Alpha-1-Antitrypsin, Serum	157		mg/dL	90 - 200	02
AAT, DNA Analysis	NEGATIVE (No mutation identified)				03
Interpretation: No alpha-1-antitrypsin mutation was detected in this individual. This analysis detects the S and Z mutations. Rare mutations (such as null alleles) will not be detected by this assay. Diagnosis cannot rely on DNA testing alone, and should be combined with phenotyping (PI typing) and/or alpha-1-antitrypsin quantitative levels for the most accurate interpretation.					
Additional Information: Alpha-1-Antitrypsin Deficiency (AATD) is a genetic disorder, inherited in a co-dominant manner. It is associated with COPD (chronic obstructive pulmonary disease), early onset emphysema, unexplained liver disease, panniculitis, C-ANCA+vasculitis, and a family history of any of these conditions. The clinical expression can be highly					

I also screened her for alpha-1-antitrypsin deficiency and AAT genetic mutations, as you can see here on this slide. Those were negative. The patient did not consume alcohol or any drugs that cause liver damage, and liver ultrasound was negative for fatty liver. Going through the diagram, that leaves autoimmune hepatitis as the only unexplored cause here.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
Microalb/Creat Ratio, Randm Ur					
Creatinine, Urine	121.9		mg/dL	15.0 - 278.0	01
Microalbumin, Urine	352.9	High	ug/mL	0.0 - 17.0	01
Microalb/Creat Ratio	289.5	High	mg/g creat	0.0 - 30.0	
Anti-dsDNA Antibodies					
Anti-DNA (DS) Ab Qn	1		IU/mL	0 - 9	01
			Negative	<5	
			Equivocal	5 - 9	
			Positive	>9	

Note that the patient also had high BUN and BUN-to-creatinine ratio. I decided to run microalbumin levels to determine whether her kidneys were not functioning well. This patient's mother had lupus, and given her muscle and joint pain and possible liver autoimmunity, I also ran an anti-dsDNA test, which is a group of antinuclear antibodies that can be high in lupus. We know that lupus can cause nephritis. Her microalbumin and microalbumin-to-creatinine ratio were both high, which does indicate poor kidney function. Her anti-dsDNA antibodies were normal, but these are only about 50 percent sensitive, so a negative result doesn't rule lupus out. At this point, I referred her to a rheumatologist for a complete workup, and this patient did in fact have lupus. She also had positive liver-kidney microsomal antibodies, so it's not uncommon to see multiple tissues affected in lupus.

Test Name	In Range	Out Of Range	Reference Range
COMPREHENSIVE METABOLIC PANEL			
GLUCOSE	85		65-99 mg/dL
			Fasting reference interval
UREA NITROGEN (BUN)	8		7-25 mg/dL
CREATININE	0.82		0.60-1.35 mg/dL
eGFR NON-AFR. AMERICAN	105		> OR = 60 mL/min/1.73m ²
eGFR AFRICAN AMERICAN	122		> OR = 60 mL/min/1.73m ²
BUN/CREATININE RATIO	NOT APPLICABLE		6-22 (calc)
SODIUM	139		135-146 mmol/L
POTASSIUM	4.1		3.5-5.3 mmol/L
CHLORIDE	103		98-110 mmol/L
CARBON DIOXIDE		31 H	19-30 mmol/L
CALCIUM	9.7		8.6-10.3 mg/dL
PROTEIN, TOTAL	7.0		6.1-8.1 g/dL
ALBUMIN	4.4		3.6-5.1 g/dL
GLOBULIN	2.6		1.9-3.7 g/dL (calc)
ALBUMIN/GLOBULIN RATIO	1.7		1.0-2.5 (calc)
BILIRUBIN, TOTAL	0.5		0.2-1.2 mg/dL
ALKALINE PHOSPHATASE	67		40-115 U/L
AST	35		10-40 U/L
ALT		70 H	9-46 U/L
CARDIO IQ(R) VITAMIN D, 25 HYDROXY, LC/MS/MS			
VITAMIN D, 25-OH, TOTAL	37		30-100 ng/mL
<p>25-OHD3 indicates both endogenous production and supplementation. 25-OHD2 is an indicator of exogenous sources, such as diet or supplementation. Therapy is based on measurement of Total 25-OHD, with levels <20 ng/mL indicative of Vitamin D deficiency, while levels between 20 ng/mL and 30 ng/mL suggest insufficiency. Optimal levels are > or = 30 ng/mL.</p>			
VITAMIN D, 25-OH, D3	37		See Below ng/mL
Reference Range: Not established			
VITAMIN D, 25-OH, D2	<4		See Below ng/mL
Reference Range: Not established			
CBC (INCLUDES DIFF/PLT)			
WHITE BLOOD CELL COUNT	5.8		3.8-10.8 Thousand/uL
RED BLOOD CELL COUNT	4.45		4.20-5.80 Million/uL
HEMOGLOBIN	14.6		13.2-17.1 g/dL
HEMATOCRIT	44.7		38.5-50.0 %
MCV		100.5 H	80.0-100.0 fL
MCH	32.8		27.0-33.0 pg
MCHC	32.7		32.0-36.0 g/dL
RDW	13.3		11.0-15.0 %
PLATELET COUNT	203		140-400 Thousand/uL
ABSOLUTE NEUTROPHILS	3323		1500-7800 cells/uL
ABSOLUTE LYMPHOCYTES	1734		850-3900 cells/uL
ABSOLUTE MONOCYTES	528		200-950 cells/uL
ABSOLUTE EOSINOPHILS	174		15-500 cells/uL
ABSOLUTE BASOPHILS	41		0-200 cells/uL

The next patient is a 55-year-old male with constipation and GI issues, fatigue, and cognitive problems. ALT is lab-high at 70. AST is functionally high at 35. Alkaline phosphatase is normal. MCV is high, and I'll come back to that in a moment. We didn't have a GGT or LDH on this patient. He got his lab work through his primary care provider, and she didn't order those markers on the initial round. Glucose, insulin, and lipids were normal. This patient was lean and had no evidence of metabolic dysfunction. Copper and zinc were normal. He wasn't taking any medication.

Infectious Diseases			
Test Name	Result	Reference Range	Lab
HEPATITIS PANEL, ACUTE W/REFLEX TO CONFIRMATION			
HEPATITIS A IGM	NON-REACTIVE	NON-REACTIVE	EN
HEPATITIS B SURFACE ANTIGEN W/REFL CONFIRM			
HEPATITIS B SURFACE ANTIGEN	NON-REACTIVE	NON-REACTIVE	EN
HEPATITIS B CORE ANTIBODY (IGM)	NON-REACTIVE	NON-REACTIVE	EN
HEPATITIS C AB W/REFL TO HCV RNA, QN, PCR			
HEPATITIS C ANTIBODY	NON-REACTIVE	NON-REACTIVE	EN
SIGNAL TO CUT-OFF	0.01	<1.00	
Physician Comments:			

He'd recently done some foreign travel, so I ran a hepatitis panel to be safe. It was normal, as you can see. I've yet to have more than a handful of patients with hepatitis in almost eight years of practice. It's just not very common in my particular patient population.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
Fe+TIBC+Fer					
Iron Bind.Cap. (TIBC)	230	Low	ug/dL	250 - 450	
UIBC	78	Low	ug/dL	150 - 375	01
Iron, Serum	152		ug/dL	40 - 155	01
Iron Saturation	66	High	%	15 - 55	
Ferritin, Serum	450	High	ng/mL	30 - 400	01
Fructosamine	243		umol/L	0 - 285	02
Published reference interval for apparently healthy subjects between age 20 and 60 is 205 - 285 umol/L and in a poorly controlled diabetic population is 228 - 563 umol/L with a mean of 396 umol/L.					
Soluble Transferrin Receptor	11.4	Low	nmol/L	12.2 - 27.3	02

Unfortunately, his primary care provider hadn't tested his iron levels, which, as you know, is extremely common. When I ran an iron panel, as you can see, he had very significant iron overload. Ferritin was 450. Iron saturation was 66 percent. UIBC was very low at 78, and TIBC was low at 230. Soluble transferrin receptor was also low at 11.4. It's less common to see elevated AST and ALT with ferritin in a high-normal or slightly elevated range. It typically occurs when ferritin is maybe 600 to 700 or higher, but it can happen, as this illustrates.

Marker	Value	Functional Range	Lab Range
Glucose	78	75 – 90	65 - 99
Hemoglobin A1c	5.6	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.5	3.2 - 5.5	2.5 - 7.1
BUN	12	13 – 18	6 - 20
Creatinine	0.74	0.85 – 1.1	0.57 - 1
BUN/Creatinine Ratio	16	9 – 23	8 - 20
Sodium	138	135 – 140	134 - 144
Potassium	3.8	4.0 – 4.5	3.5 - 5.2
Chloride	98	100 – 106	97 - 108
CO2	21	25 – 30	18 - 29
Calcium	9.1	9.2 – 10.1	8.7 - 10.2
Phosphorus	4.5	3.5 – 4.0	2.5 - 4.5
Magnesium	1.9	2.0 – 2.6	1.6 - 2.6
Protein, total	7.6	6.9 – 7.4	6.0 - 8.5
Albumin	4.3	4.0 – 5.0	3.5 - 5.5
Globulin	3.3	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.3	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.3	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	141	42 – 107	39 - 117
LDH	196	140 - 180	119 - 226
AST	16	10 - 30	0 - 40
ALT	27	10 - 22	0 - 32
GGT	98	0 - 28	0 - 60
TIBC	436	250 – 350	250 - 450
UIBC	416	150 - 375	150 - 375
Iron	20	85 – 135	35 - 155
Iron saturation	5	15 – 45	15 - 55
Ferritin	6	15 - 120	15 - 150
Cholesterol, total	145	150 – 250	100 - 199
Triglycerides	127	50 – 100	0 - 149
HDL	47	55 – 85	> 39
LDL	73	0 – 175	0 - 99
T. Chol / HDL Ratio	3.1	< 3	0 - 4.4
Triglycerides / HDL Ratio	2.70	< 2	
TSH	2.660	0.5 – 2.5	0.450 - 4.500
T4, total	7.0	6.0 – 12	4.5 - 12.0
T3 Uptake	27	28 - 35	24 - 39
T3, Total	126	100 – 180	71 - 180
Vitamin D, 25-hydroxy	32.9	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
WBC	8.1	5.0 – 8.0	3.4 - 10.8
RBC	5.11	4.4 – 4.9	3.77 - 5.28
Hemoglobin	11.2	13.5 - 14.5	11.1 - 15.9
Hematocrit	37.2	37 - 44	34.0 - 46.6
MCV	73	85 – 92	79 - 97
MCH	21.9	27.7 – 32.0	26.6 - 33.0
MCHC	30.1	32 – 35	31.5 - 35.7
RDW	17.6	11.5 – 15.0	12.3 - 15.4
Platelets	376	150 – 415	150 - 379
Neutrophils	46	40 – 60	
Lymphocytes	38	25 – 40	
Monocytes	9	4.0 – 7.0	
Eosinophils	6	0.0 – 3.0	
Basophils	1	0.0 – 3.0	
Eos (Absolute)	0.5		0.0 - 0.4
Additional Tests:			
CRP-hs	5.93	< 1.0	0.00 - 3.00
Homocysteine	11.2	< 7.0	0.0 - 15.0
Vitamin B-12	389	450 – 2000	211 - 946
Copper	134		72 - 166
Zinc	79		56 - 134
Zinc / Copper Ratio	0.59	> 0.85	
Serum Methylmalonic Acid (MMA)	107	0 - 325	0 - 378

The next patient is a 22-year-old female with ulcerative colitis and celiac disease. We've seen her case a couple of times now. Her ALT is functionally high. AST is normal. LDH is functionally high. Alkaline phosphatase is lab-high, and GGT is lab-high. This is an extrahepatic case of elevated ALT. In her case, it's inflammatory bowel disease that is leading to elevations of the aminotransferases.

Marker	Value	Functional Range	Lab Range
Glucose	82	75 - 85	65 - 99
Hemoglobin Alc	5.2	4.4 - 5.4	4.8 - 5.6
Uric Acid	3.9	W: 3.2 - 5.5	2.5 - 7.1
BUN	15	13 - 18	6 - 20
Creatinine	1.01	0.85 - 1.1	0.57 - 1.00
Sodium	143	135 - 140	134 - 144
Potassium	4.5	4.0 - 4.5	3.5 - 5.2
Chloride	102	100 - 106	97 - 108
CO2	24	25 - 30	18 - 29
Calcium	10.0	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.8	3.5 - 4.0	2.5 - 4.5
Magnesium	2.1	2.0 - 2.5	1.6 - 2.6
Protein, total	7.2	6.9 - 7.4	6.0 - 8.5
Albumin	4.9	4.0 - 5.0	3.5 - 5.5
Globulin	2.3	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.1	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	1.1	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	65	42 - 107	39 - 117
LDH	159	140 - 180	119 - 226
AST	33	W: 10-30	0 - 40
ALT	42	W: 10-22	0 - 32
GGT	15	10 - 26	0 - 60
TIBC	289	250 - 350	250 - 450
UIBC	211	150 - 375	150 - 375
Iron	78	85 - 135	35 - 155
Iron saturation	27	15 - 40	15 - 55
Ferritin	167	W: 10-122	15 - 150
Cholesterol, total	207	150 - 250	100 - 199
Triglycerides	41	50 - 100	0 - 149
HDL	82	55 - 85	> 39
LDL	117	0 - 175	0 - 99
Triglycerides / HDL Ratio	0.5	< 2	< 3.8
TSH	1.020	0.5 - 2.5	0.450 - 4.500
T4, total	5.7	6.0 - 12	4.5 - 12.0
T3 Uptake	31	W: 28-35	24 - 39
T3, Total	60	100 - 180	71 - 180
Vitamin D, 25-hydroxy	77.4	35 - 60	30.0 - 100.0
WBC	4.9	5.0 - 8.0	3.4 - 10.8
RBC	5.07	4.4 - 4.9	3.77 - 5.28
Hemoglobin	15.0	W: 13.5-14.5	11.1 - 15.9

	Value	Functional Range	Lab Range
Hematocrit	45.5	W: 37-44	34.0 - 46.6
MCV	90	85 - 92	79 - 97
MCH	29.6	27.7 - 32.0	26.6 - 33.0
MCHC	33.0	32 - 35	31.5 - 35.7
RDW	13.3	11.5 - 15.0	12.3 - 15.4
Platelets	327	150 - 415	150 - 379
Neutrophils	54	40 - 60	
Lymphocytes	38	25 - 40	
Monocytes	5	4.0 - 7.0	
Eosinophils	2	0.0 - 3.0	
Basophils	1	0.0 - 3.0	
B-12	1540	450 - 2000	211 - 946
Additional Tests:			
CRP-hs	0.12		0.00 - 3.00
Homocysteine	7.4		0.00 - 15.0
Sed Rate (Westergren)			0 - 32
T3, Free	2.1		2.0 - 4.4
T4, Free	0.95		0.82 - 1.77
Thyroid Peroxide (TPO)	108		0 - 34
Thyroglobulin, Antibody	<0.0		0.0 - 0.9
TGF-B1			344 - 2382

The next patient is a 34-year-old female with anovulation, migraines, and prior diagnosis of Hashimoto's. ALT is lab-high at 42. AST is functionally high at 33. Alkaline phosphatase, GGT, and LDH are normal. Her TSH is normal, but her T4 and T3 are low, and TPO antibodies are positive, so this is indicative of Hashimoto's. When a patient says they have a prior diagnosis, it usually means they will be currently also diagnosed whether they have clinical hypothyroidism or not. Remember that hypothyroidism, particularly Hashimoto's, is one of the extrahepatic causes of elevated aminotransferases, and that seemed to be what was happening here.

Next, let's talk about a workup for elevated GGT. This occurs in diseases of the liver, biliary tract, and pancreas, and it correlates well with alkaline phosphatase, as you'll see in the upcoming cases. The major clinical value of GGT above and beyond its role as a marker of metabolic dysfunction, which we talked about in the iron overload unit, is to confirm that an elevation in alkaline phosphatase is related to liver dysfunction, since GGT is not elevated in bone breakdown.

GGT is not 100% specific for liver disease.

GGT is not 100 percent specific for liver and gallbladder disease. It can be elevated in isolation in barbiturate use, alcoholism, and, of course, in metabolic disease. It's not especially helpful in the context of liver disease on its own, but it can be useful with other markers.

Marker	Value	Functional Range	Lab Range
Glucose	95	75 - 85	65 - 99
Hemoglobin Alc	5.4	4.4 - 5.4	4.8 - 5.6
Uric Acid	7.8	W: 3.2 - 5.5	2.5 - 7.1
BUN	14	13 - 18	6 - 24
Creatinine	0.83	0.85 - 1.1	0.57 - 1.00
Sodium	141	135 - 140	134 - 144
Potassium	4.6	4.0 - 4.5	3.5 - 5.2
Chloride	105	100 - 106	97 - 108
CO2	20	25 - 30	18 - 29
Calcium	10.4	9.2 - 10.1	8.7 - 10.2
Phosphorus	2.5	3.5 - 4.0	2.5 - 4.5
Magnesium	2.0	2.0 - 2.5	1.6 - 2.6
Protein, total	6.8	6.9 - 7.4	6.0 - 8.5
Albumin	4.2	4.0 - 5.0	3.5 - 5.5
Globulin	2.6	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.6	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.6	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	61	42 - 107	39 - 117
LDH	145	140 - 180	0 - 214
AST	33	10 - 26	0 - 40
ALT	55	10 - 26	0 - 32
GGT	44	10 - 26	0 - 60
TIBC	326	250 - 350	250 - 450
UIBC	226	150 - 375	150 - 375
Iron	100	85 - 135	35 - 155
Iron saturation	31	15 - 40	15 - 55
Ferritin	73	W: 10-122	15 - 150
Cholesterol, total	261	150 - 250	100 - 199
Triglycerides	233	50 - 100	0 - 149
HDL	62	55 - 85	> 39
LDL	152	0 - 175	0 - 99
Triglycerides / HDL Ratio	3.758	< 2	< 3.8
TSH	3.060	0.5 - 2.5	0.450 - 4.50
T4, total	5.8	6.0 - 12	4.5 - 12.0
T3 Uptake	35	W: 28-35	24 - 39
T3, Total	120	100 - 180	71 - 180
Vitamin D, 25-hydroxy	16.1	35 - 60	30.0 - 100.0
WBC	7.4	5.0 - 8.0	3.4 - 10.8
RBC	4.35	4.4 - 4.9	3.77 - 5.28
Hemoglobin	13.2	W: 13.5-14.5	11.1 - 15.9

	Value	Functional Range	Lab Range
Hematocrit	40.7	W: 37-44	34.0 - 46.6
MCV	94	85 - 92	79 - 97
MCH	30.3	27.7 - 32.0	26.6 - 33.0
MCHC	32.4	32 - 35	31.5 - 35.7
RDW	13.0	11.5 - 15.0	12.3 - 15.4
Platelets	310	150 - 415	150 - 379
Neutrophils	59	40 - 60	40 - 74
Lymphocytes	32	25 - 40	14 - 46
Monocytes	6	4.0 - 7.0	4 - 12
Eosinophils	2	0.0 - 3.0	0 - 5
Basophils	1	0.0 - 3.0	0 - 3
B-12	974	450 - 2000	211 - 946
Additional Tests:			
C- Reactive Protein	5.06		0.00 - 3.00
Homocysteine	6.8		0.00 - 15.0
Sed Rate (Westergren)	24		0 - 32

The next patient is a 64-year-old female with weight loss as her sole concern. GGT is not lab-high, but it's well out of the functional range. ALT is lab-high. AST is functionally high. LDH is normal, and in this case, alkaline phosphatase is completely normal, so it's not correlating with GGT. Note that several markers of metabolic dysfunction are present: high uric acid, high triglycerides, high CRP, low vitamin D, and several markers out of the functional range, including poor thyroid function. This is almost certainly fatty liver that is causing these elevations in aminotransferases and GGT.

LDH is not useful on its own as marker of liver dysfunction.

LDH is also a nonspecific marker of liver dysfunction that correlates with other liver function markers. As mentioned before, five isoenzymes of LDH are present in the serum, and the slowest

migrating band predominates in the liver. You can run LDH isoenzymes if LDH is elevated to help determine the source of the elevation. LDH is not useful on its own as a marker of liver dysfunction because it's not as sensitive as AST and ALT, and it's not specific enough even when the isoenzymes are used, but like GGT, it can be helpful in establishing a pattern.

Marker	Value	Functional Range	Lab Range
Glucose	75	75 – 85	65 - 99
Hemoglobin A1c	5.1	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.2	3.2 - 5.5	2.5 - 7.1
BUN	21	13 – 18	6 - 20
Creatinine	1.10	0.85 – 1.1	0.57 - 1
Sodium	140	135 – 140	134 - 144
Potassium	4.4	4.0 – 4.5	3.5 - 5.2
Chloride	101	100 – 106	97 - 108
C02	22	25 – 30	18 - 29
Calcium	9.4	9.2 – 10.1	8.7 - 10.2
Phosphorus	4.5	3.5 – 4.0	2.5 - 4.5
Magnesium	2.0	2.0 – 2.5	1.6 - 2.6
Protein, total	6.7	6.9 – 7.4	6.0 - 8.5
Albumin	4.6	4.0 – 5.0	3.5 - 5.5
Globulin	2.1	2.4 – 2.8	1.5 - 4.5
A/G ratio	2.2	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.5	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	41	42 – 107	39 - 117
LDH	425	140 - 180	119 - 226
AST	98	10 - 30	0 - 40
ALT	36	10 - 22	0 - 32
GGT	9	10 - 26	0 - 60
TIBC	316	250 – 350	250 - 450
UIBC	167	150 - 375	150 - 375
Iron	149	85 – 135	35 - 155
Iron saturation	47	15 – 40	15 - 55
Ferritin	40	10 - 122	15 - 150
Cholesterol, total	195	150 – 250	100 - 189
Triglycerides	82	50 – 100	0 - 114
HDL	67	55 – 85	> 39
LDL	112	0 – 175	0 - 119
Triglycerides / HDL Ratio	1.22	< 2	< 3.8
TSH	1.950	0.5 – 2.5	0.45 - 4.50
T4, total	5.3	6.0 – 12	4.5 - 12
T3 Uptake	26	28 - 35	24 - 39
T3, Total	91	100 – 180	71 - 180

Marker	Value	Functional Range	Lab Range
Vitamin D, 25-hydroxy	38.8	35 - 60	30 - 100
WBC	8.3	5.0 - 8.0	3.4 - 10.8
RBC	4.84	4.4 - 4.9	3.77 - 5.28
Hemoglobin	14	13.5 - 14.5	11.1 - 15.9
Hematocrit	43.7	37 - 44	34 - 46.6
MCV	90	85 - 92	79 - 97
MCH	28.9	27.7 - 32.0	26.6 - 33.0
MCHC	32.0	32 - 35	31.5 - 35.7
RDW	12.6	11.5 - 15.0	12.3 - 15.4
Platelets	258	150 - 415	150 - 379
Neutrophils	61	40 - 60	
Lymphocytes	31	25 - 40	
Monocytes	5	4.0 - 7.0	
Eosinophils	2	0.0 - 3.0	
Basophils	1	0.0 - 3.0	
Additional Tests:			
T3, Free	2.6		2 - 4.4
T4, Free	1.08		0.82 - 1.77
CRP-hs	0.51		0.00 - 3.00
Homocysteine	9.7		0.0 - 15.0
Vitamin B-12	595	450 - 2000	211 - 946

The next patient is a 26-year-old female with chief complaint of GI issues, anxiety and panic attacks, hair loss, fatigue, lethargy, hypotension, acne, dry skin, and eczema. These issues began after travel in Thailand four years prior to her coming to see me. ALT, AST, LDH, BUN, and creatinine are all lab-high, and alkaline phosphatase and GGT are low-normal.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL
LD Isoenzymes				
LDH	165		IU/L	119 - 226
LD Isoenzymes:				
(LD) Fraction 1	23		%	17 - 32
(LD) Fraction 2	24	Low	%	25 - 40
(LD) Fraction 3	23		%	17 - 27
(LD) Fraction 4	12		%	5 - 13
(LD) Fraction 5	18		%	4 - 20

We ran LDH isoenzymes, and her LDH was normal this time at 165, but she had slightly low fraction #2, which is not clinically significant at this level. None of the fractions were elevated. Testing is ongoing in this patient. It's not yet clear what is causing her elevated ALT and AST. We've pretty much ruled out most of the causes that are listed in the algorithm back there, but we're working on addressing some other underlying issues that she has, and then our plan is to retest and see if they have gone down.

**Alkaline phosphatase is
most likely marker of liver
dysfunction when GGT is
also high.**

Finally, let's talk about how to work up high alkaline phosphatase. You should always retest alkaline phosphatase to confirm if it is initially elevated, but if on the retest it is high, and GGT is also high, that would be strongly suggestive of a liver issue. Patient history can point to possible causes, including medications, ulcerative colitis, previous cancer, and sarcoidosis. Ultrasound can exclude biliary obstruction or suggest an infiltrative process. If medication is suspected, ask the patient to stop the drug and retest in six to eight weeks. If GGT is normal or equivocal, you could consider running alkaline phosphatase isoenzymes to see where the elevation is coming from, whether it is the intestine, the liver, or the bone.

Marker	Value	Functional Range	Lab Range
Glucose	82	75 - 90	65 - 99
Hemoglobin A1c	5.3	4.4 - 5.4	4.8 - 5.6
Uric Acid	5.0	3.2 - 5.5	2.0 - 5.8
BUN	11	13 - 18	5 - 18
Creatinine	0.54	0.7 - 1.0	0.39 - 0.7
BUN/Creatinine Ratio	20	9 - 23	9 - 25
Sodium	140	135 - 140	134 - 144
Potassium	4.1	4.0 - 4.5	3.5 - 5.2
Chloride	100	100 - 106	97 - 108
CO2	24	25 - 30	17 - 27
Calcium	9.8	9.2 - 10.1	9.1 - 10.5
Phosphorus	4.8	3.0 - 4.0	2.8 - 6.2
Magnesium	1.9	2.0 - 2.6	1.6 - 2.3
Protein, total	6.7	6.9 - 7.4	6.0 - 8.5
Albumin	4.6	4.0 - 5.0	3.5 - 5.5
Globulin	2.1	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.2	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.3	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	423	42 - 107	134 - 349
LDH	216	140 - 180	166 - 290
AST	31	10 - 23	0 - 60
ALT	18	10 - 20	0 - 28
GGT	14	5 - 21	0 - 60
TIBC	329	275 - 425	250 - 450
UIBC	264	175 - 350	131 - 425
Iron	65	40 - 135	28 - 147
Iron saturation	20	17 - 45	15 - 55
Ferritin	90	30 - 100	15 - 79
Vitamin B-12	641	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	63.2	35 - 60	30.0 - 100.0
Cholesterol, total	138	150 - 250	100 - 169
Triglycerides	46	50 - 100	0 - 74
HDL	66	55 - 85	> 39
LDL	63	0 - 175	0 - 109
T. Chol / HDL Ratio	2.1	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.70	< 2	< 3.8
CRP-hs	5.26	< 1.0	0.00 - 3.00
Homocysteine	7.2	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	2.520	0.5 – 2.5	0.60 - 4.84
T4, total	8.0	6.0 – 12	4.5 - 12
T3 Uptake	28	28 - 35	22 - 35
T3, Total	152	100 – 180	92 - 219
Copper	120		72 - 166
Zinc	94		56 - 134
Zinc / Copper Ratio	0.78	> 0.85	
Serum Methylmalonic Acid (MMA)	118	< 300	0 - 378
WBC	9.0	5.0 – 8.0	3.7 - 10.5
RBC	4.94	4.4 – 4.9	3.91 - 5.45
Hemoglobin	13.7	13.5 - 14.5	11.7 - 15.7
Hematocrit	40.9	37 - 44	34.8 - 45.8
MCV	83	85 – 92	77 - 91
MCH	27.7	27.7 – 32.0	25.7 - 31.5
MCHC	33.5	32 – 35	31.7 - 36.0
RDW	12.9	11.5 – 15.0	12.3 - 15.1
Platelets	193	150 – 415	176 - 407
Neutrophils	67	40 – 60	
Lymphocytes	26	25 – 40	
Monocytes	6	4.0 – 7.0	
Eosinophils	1	0.0 – 3.0	
Basophils	0	0.0 – 3.0	
Neutrophils (Absolute)	6.1		1.2 - 6

The next patient is an eight-year-old girl, born eight weeks premature. She went through two abdominal surgeries and stayed in intensive care in the pediatric department at the hospital for about 10 days of the first month of her life. Her main current complaints were constipation, overweight, early development of underarm hair, and possible hormonal imbalance. Her ALT is normal. AST is functionally high. Alkaline phosphatase is lab-high at 423. LDH is functionally high. CRP and ferritin are also high, indicating inflammation.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
LD Isoenzymes					
LDH	213		IU/L	166 - 290	01
LD Isoenzymes:					02
(LD) Fraction 1	28		%	17 - 32	02
(LD) Fraction 2	34		%	25 - 40	02
(LD) Fraction 3	21		%	17 - 27	02
(LD) Fraction 4	8		%	5 - 13	02
(LD) Fraction 5	9		%	4 - 20	02
Alk Phos Isoenzyme					
Alkaline Phosphatase, S	427	High	IU/L	134 - 349	01
Liver Fraction:	9		%	2 - 25	02
Bone Fraction:	91		%	69 - 97	02
Intestinal Frac.:	0		%	0 - 8	02
Estrogens, Total					
	40		pg/mL		02
			Prepubertal	<40	
			Female Cycle:		
			1-10 Days	61 - 394	
			11-20 Days	122 - 437	
			21-30 Days	156 - 350	
			Post-Menopausal	<40	
			HMG Treatment for Ovulation		
			Induction:	400 - 800	

We ran both LDH and alkaline phosphatase isoenzymes, and this is a really important point here. Alkaline phosphatase is still elevated, and 91 percent of it is from bone. Now, this might seem concerning on the surface, but when you run alkaline phosphatase in kids, you will often see it high, and it will almost always be 90 percent or more in bone. That is because when kids are this age, they are growing very quickly, and there is a lot of bone turnover. This is not pathological, especially when the alkaline phosphatase elevation is mild. This can cause some concern if you're not aware of it, but almost always with these mild elevations in kids who are still growing, especially if you do the isoenzymes and it's all in bone, it's not really anything to be concerned about.

Her LDH was normal on follow-up, but the rapid growing still wouldn't explain the high CRP and ferritin or borderline-high prepubertal estrogen, which you can see here. This patient had fungal overgrowth and a lot of other gut issues, so our plan was to address the sources of inflammation and retest given the variability of CRP and ferritin, then continue to track her alkaline phosphatase, and refer out if it went out or reached a level that would concern us, but otherwise, I think this was most likely gut inflammation that is causing some systemic inflammation, and it's something that can be addressed within the functional medicine context.

Okay, that's it for the impaired liver function presentation. In the next presentation, we'll talk about gallbladder dysfunction.