

Blood Chemistry Review II - Part One

Hey, everybody. This week we're going to do the second part of the blood chemistry panel review.

The first patient is a 36-year-old female with chief complaints of anxiety, panic attacks, digestive issues, numbness and tingling in the extremities, sore throat, reflux, and extreme fatigue.

Marker	Value	Functional Range	Lab Range
Glucose	92	75 - 90	65 - 99
Hemoglobin A1c	5.4	4.4 - 5.4	4.8 - 5.6
Uric Acid	5.1	3.2 - 5.5	2.5 - 7.1
BUN	10	13 - 18	6 - 20
Creatinine	0.86	0.7 - 1.0	0.57 - 1
BUN/Creatinine Ratio	12	9 - 23	8 - 20
eGFR if Non-African American	87		> 59
eGFR if African American	101		> 59
Sodium	138	135 - 140	134 - 144
Potassium	4.4	4.0 - 4.5	3.5 - 5.2
Chloride	101	100 - 106	97 - 108
CO2	23	25 - 30	18 - 29
Calcium	9.0	9.2 - 10.1	8.7 - 10.2
Parathyroid Hormone, Intact	27	30 - 60	15 - 65
Phosphorus	3.0	3.0 - 4.0	2.5 - 4.5
Magnesium	2.2	2.0 - 2.6	1.6 - 2.3
Protein, total	7.0	6.9 - 7.4	6.0 - 8.5
Albumin	4.4	4.0 - 5.0	3.5 - 5.5
Globulin	2.6	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.7	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.3	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	47	42 - 107	39 - 117
LDH	113	140 - 180	119 - 226
AST	12	0 - 23	0 - 40
ALT	6	0 - 20	0 - 32
GGT	8	0 - 21	0 - 60
TIBC	247	275 - 425	250 - 450
UIBC	153	175 - 350	131 - 425
Iron	94	40 - 135	27 - 159
Iron saturation	38	17 - 45	15 - 55
Ferritin	55	30 - 100	15 - 150
Vitamin B-12	922	450 - 2000	211 - 946
Folate, Serum	7.3	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	54.5	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	30.6	35 - 60	30.0 - 100.0
Cholesterol, total	153	150 - 230	100 - 199
Triglycerides	81	50 - 100	0 - 149
HDL	46	55 - 85	> 39
LDL	91	0 - 140	0 - 99
T. Chol / HDL Ratio	3.3	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.76	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	2.9	< 1.0	0.00 - 3.00
Homocysteine	12.4	< 7.0	0.0 - 15.0
TSH	1.200	0.5 - 2.0	0.45 - 4.50
T4, total	8.2	6.0 - 12	4.5 - 12
T3 Uptake	31	28 - 35	24 - 39
T3, Total	110	100 - 180	71 - 180
T3, Free	2.8	2.5 - 4.0	2 - 4.4
T4, Free	1.25	1 - 1.5	0.82 - 1.77
Reverse T3	16.1	9 - 21	9.2 - 24.1
Thyroid - TPO Ab	23		0 - 34
Thyroid - TGA	<1.0		0 - 0.9
Copper	91	81 - 157	72 - 166
Zinc	86	64 - 126	56 - 134
Zinc / Copper Ratio	0.95	> 0.85	
Serum Methylmalonic Acid (MMA)	123	< 300	0 - 378
WBC	4.0	5.0 - 8.0	3.4 - 10.8
RBC	3.77	4.4 - 4.9	3.77 - 5.28
Hemoglobin	12.1	13.5 - 14.5	11.1 - 15.9
Hematocrit	35.8	37 - 44	34 - 46.6
MCV	95	85 - 92	79 - 97
MCH	32.1	27.7 - 32.0	26.6 - 33.0
MCHC	33.8	32 - 35	31.5 - 35.7
RDW	12.0	11.5 - 15.0	12.3 - 15.4
Platelets	308	150 - 415	150 - 379
Neutrophils	56	40 - 60	
Lymphocytes	37	25 - 40	
Monocytes	6	4.0 - 7.0	
Eosinophils	1	0.0 - 3.0	
Basophils	0	0.0 - 3.0	

Her fasting glucose is functionally high at 92, but her A1c and triglycerides are normal. HDL is a little low at 46. LDH, lactate dehydrogenase, is lab-low, which as you know can be a marker for reactive hypoglycemia, so this could be the early stages of a blood sugar issue. You would want to get postmeal glucose with a glucometer, fructosamine, insulin, leptin, and perhaps other markers of metabolic function, using the True Health Diagnostics* panel to make a better assessment.

<* **Note:** True Health Diagnostics is no longer in business. See [this post](#) for the latest updates.>

Her TIBC, total iron binding capacity, is lab-low, but her other iron markers are completely normal. Remember that TIBC is not as reliable as UIBC, so I think it is unlikely that there is a problem here, although you could retest the iron panel with ferritin just to be sure.

Her 25(OH)D is low at 30.6, almost out of the lab range. Calcium is a bit on the low end of the range at 9.0, but look at parathyroid hormone. It is optimally suppressed at 27, so this patient is unlikely to be deficient in vitamin D.

C-reactive protein is 2.9, which indicates there is some inflammation happening. Homocysteine is 12.4, which supports that. If you look over at serum B12, it is normal at 922, and MMA is normal at

123, but given numbness and tingling and the homocysteine of 12.4, you may want to look at urine MMA and holotranscobalamin, if these are available, because numbness and tingling, of course, are signs of possible B12 deficiency, especially because this patient does have functional anemia. Red blood cells, hemoglobin, and hematocrit are low, and MCV and MCH are borderline high, so this is suggestive of either B12, folate, or B6-deficient anemia rather than iron-deficient anemia, and that is consistent with the labs that we already have. Serum folate is 7.3, which is low-normal in the functional range, so you would definitely want to consider folate deficiency, look at urine FIGLU, and maybe do a more extensive functional methylation panel.

Finally, RDW is low. Slightly low RDW is not of clinical significance. This just means there is a little less variation in the width of red cells, which isn't a bad thing. High RDW is what we would be more concerned with, and that is more of an indicator of anemia.

For follow-up, we would do maybe an HDRI methylation panel, which is probably contributing to her mental health issues, anxiety, and panic attacks, one of her primary complaints; do some more advanced metabolic testing; and then check for sources of inflammation.

The next patient is an 18-year-old female with chief complaint of IBS and food sensitivities, particularly with gluten and dairy. She is a college student and gets eight hours of sleep but wakes feeling unrefreshed. She is on oral contraceptive pill, has frequent colds and flus, and low energy.

Marker	Value	Functional Range	Lab Range
Glucose	87	75 - 90	65 - 99
Hemoglobin A1c	5.5	4.4 - 5.4	4.8 - 5.6
Uric Acid	5.7	3.2 - 5.5	2.4 - 6.3
BUN	11	13 - 18	5 - 18
Creatinine	0.86	0.85 - 1.1	0.57 - 1.00
BUN/Creatinine Ratio	13	9 - 23	9 - 25
Sodium	135	135 - 140	134 - 144
Potassium	4.8	4.0 - 4.5	3.5 - 5.2
Chloride	96	100 - 106	97 - 108
CO2	24	25 - 30	18 - 29
Calcium	9.8	9.2 - 10.1	8.9 - 10.4
Phosphorus	4.0	3.5 - 4.0	2.5 - 5.3
Magnesium	1.9	2.0 - 2.6	1.6 - 2.3
Protein, total	7.5	6.9 - 7.4	6.0 - 8.5
Albumin	4.4	4.0 - 5.0	3.5 - 5.5
Globulin	3.1	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.4	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.7	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	42	42 - 107	45 - 101
LDH	134	140 - 180	114 - 209
AST	18	10 - 30	0 - 40
ALT	14	10 - 22	0 - 24
GGT	12	0 - 28	0 - 60
TIBC	423	275 - 425	250 - 450
UIBC	336	175 - 350	131 - 425
Iron	87	40 - 135	26 - 169
Iron saturation	21	17 - 45	15 - 55
Ferritin	37	30 - 100	15 - 77
Vitamin B-12	584	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	42.9	35 - 60	30.0 - 100.0
Cholesterol, total	244	150 - 250	100 - 169
Triglycerides	116	50 - 100	0 - 89
HDL	65	55 - 85	> 39
LDL	156	0 - 175	0 - 109
T. Chol / HDL Ratio	3.8	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.78	< 2	< 3.8
CRP-hs	2.33	< 1.0	0.00 - 3.00
Homocysteine	8.9	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	1.310	0.5 – 2.5	0.45 - 4.500
T4, total	8.5	6.0 – 12	4.5 - 12.0
T3 Uptake	22	28 - 35	23 - 35
T3, Total	142	100 – 180	71 - 180
Copper	178		72 - 166
Zinc	107		56 - 134
Zinc / Copper Ratio	0.60	> 0.85	
Serum Methylmalonic Acid (MMA)	130	0 - 325	0 - 378
WBC	6.3	5.0 – 8.0	3.4 - 10.8
RBC	4.62	4.4 – 4.9	3.77 - 5.28
Hemoglobin	15.3	13.5 - 14.5	11.1 - 15.9
Hematocrit	45.5	37 - 44	34 - 46.6
MCV	99	85 – 92	79 - 97
MCH	33.1	27.7 – 32.0	26.6 - 33.0
MCHC	33.6	32 – 35	31.5 - 35.7
RDW	13.2	11.5 – 15.0	12.3 - 15.4
Platelets	315	150 – 415	150 - 379
Neutrophils	57	40 – 60	
Lymphocytes	34	25 – 40	
Monocytes	7	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

A1c is borderline high at 5.5. Fasting glucose is normal at 87. Triglycerides are 116, a little high. Uric acid is 5.7, a little high in the functional range for both of those, so blood sugar could be an issue, and you would want to do more testing.

Serum chloride is barely out of the lab range at 96. Decreased chloride occurs with any condition that causes loss of sodium as well as congestive heart failure, vomiting, Addison's disease, chronic lung disease, or metabolic calculosis. When it is just a little bit low like this, it is most typically a sign of dehydration, and her hemoglobin and hematocrit are mildly elevated in the functional range, which are also, as you know, markers of dehydration, so I think that is what is probably going on here.

Magnesium is 1.9, which means there is some chance of deficiency, although not super high. Protein, globulin, and albumin-to-globulin ratio are barely out of the functional range. I do not think that is likely to be significant. Alkaline phosphatase is low, so you would want to think zinc or thyroid first. Zinc-to-copper ratio is low. Zinc is well within the normal range, but serum copper is elevated out of the lab range at 178, so I would run ceruloplasmin and 24-hour urine copper for more information here.

Total cholesterol is 244. HDL is 65. That leads to a total cholesterol-to-HDL ratio of 3.8, so I would do more advanced lipid testing. I'd look at LDL-P and Lp(a)-P, especially because this patient is only 18 years old, so this is a pretty high cholesterol level for someone this age. She could be a carrier of familial hypercholesterolemia, so you would want to know that.

C-reactive protein is 2.33, so this is indicative of inflammation along with high copper and a low copper-to-zinc ratio. Homocysteine is 8.9, which is a little high, also an inflammatory marker. Serum B12 and serum MMA are normal, but her MCV and MCH are lab-high. Those are also markers potentially of B12 or folate deficiency, so you would want to check urine MMA and urine FIGLU and do further workup there.

T3 uptake is lab-low, and excess estrogens can cause that. Remember, she is on oral contraceptives, so you'll often see low T3 uptake in women who are on oral contraception.

For follow-up, we would want to do more advanced metabolic and cardiovascular testing with True Health Diagnostics*. Continue looking for a source of inflammation with the gut testing, HPA axis testing, methylation, B12, and folate to see what is going on with the anemia here. You would want to do further investigation into copper that I mentioned, and then have her pay attention to fluid intake between now and the retest.

<* **Note:** *True Health Diagnostics is no longer in business. See [this post](#) for the latest updates.*>

The next patient is a 47-year-old female with chief complaints of abdominal distention, previous diagnosis of SIBO, and says that she looks five months' pregnant, although she is not pregnant. She has a long history of digestive issues, especially constipation, PMS with bloating, and circadian disruption. She is tired in the morning and wired at night. Intense food cravings, and she finds it difficult to stick with a healthy diet.

Marker	Value	Functional Range	Lab Range
Glucose	80	75 - 90	65 - 99
Hemoglobin A1c	4.5	4.4 - 5.4	4.8 - 5.6
Uric Acid	5.0	3.2 - 5.5	2.5 - 7.1
BUN	12	13 - 18	6 - 24
Creatinine	0.68	0.85 - 1.1	0.57 - 1
BUN/Creatinine Ratio	18	9 - 23	9 - 23
Sodium	142	135 - 140	134 - 144
Potassium	4.1	4.0 - 4.5	3.5 - 5.2
Chloride	102	100 - 106	97 - 108
CO2	24	25 - 30	18 - 29
Calcium	9.3	9.2 - 10.1	8.7 - 10.2
Phosphorus	2.5	3.5 - 4.0	2.5 - 4.5
Magnesium	1.9	2.0 - 2.6	1.6 - 2.3
Protein, total	6.7	6.9 - 7.4	6.0 - 8.5
Albumin	4.5	4.0 - 5.0	3.5 - 5.5
Globulin	2.2	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.0	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.4	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	58	42 - 107	39 - 117
LDH	134	140 - 180	119 - 226
AST	17	10 - 30	0 - 40
ALT	16	10 - 22	0 - 32
GGT	12	< 13	0 - 60
TIBC	377	275 - 425	250 - 450
UIBC	302	175 - 350	131 - 425
Iron	75	40 - 135	27 - 159
Iron saturation	20	17 - 45	15 - 55
Ferritin	17	30 - 100	15 - 150
Vitamin B-12	421	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	55.2	35 - 60	30.0 - 100.0
Cholesterol, total	198	150 - 250	100 - 199
Triglycerides	75	50 - 100	0 - 149
HDL	65	55 - 85	> 39
LDL	118	0 - 175	0 - 99
T. Chol / HDL Ratio	3.0	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.15	< 2	< 3.8
CRP-hs	2.07	< 1.0	0.00 - 3.00
Homocysteine	9.5	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	1.500	0.5 – 2.5	0.45 - 4.50
T4, total	8.3	6.0 – 12	4.5 - 12
T3 Uptake	28	28 - 35	24 - 39
T3, Total	116	100 – 180	71 - 180
Copper	137		72 - 166
Zinc	78		56 - 134
Zinc / Copper Ratio	0.57	> 0.85	
Serum Methylmalonic Acid (MMA)	99	< 300	0 - 378
WBC	7.9	5.0 – 8.0	3.4 - 10.8
RBC	4.84	4.4 – 4.9	3.77 - 5.28
Hemoglobin	14.1	13.5 - 14.5	11.1 - 15.9
Hematocrit	40.9	37 - 44	34 - 46.6
MCV	85	85 – 92	79 - 97
MCH	29.1	27.7 – 32.0	26.6 - 33.0
MCHC	34.5	32 – 35	31.5 - 35.7
RDW	14.8	11.5 – 15.0	12.3 - 15.4
Platelets	374	150 – 415	150 - 379
Neutrophils	56	40 – 60	
Lymphocytes	32	25 – 40	
Monocytes	8	4.0 – 7.0	
Eosinophils	3	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

Her A1c is lab-low at 4.5. This is likely nonpathological, but some studies do show a correlation between low A1c and chronic disease such as autoimmunity and liver disease. A variety of markers are out of the functional range here, but none is likely significant, in my opinion, except for possibly magnesium, which is 1.9. Ferritin, which is 17, suggests the early stages of iron deficiency. B12, which is 421, borderline low in the functional range, and that may be significant because homocysteine is 9.5, so a couple signs of possible B12 deficiency.

CRP is 2, so that is indicative of some inflammation, and the zinc-to-copper ratio is low at 0.57. The monocytes are functionally high at 8, so all of that points to some inflammation.

To follow up, you would want to find the source of that inflammation. Check MMA and FIGLU to see if they are contributing to high homocysteine. Watch for iron deficiency, given the low ferritin of 17, and then maybe consider supplementation with magnesium because of her borderline-low levels and because constipation is one of her main complaints.

The next patient is a 48-year-old male with chief complaints of psoriasis, rectal itching, prior prostatitis, memory loss, overweight, stress, and anxiety.

Marker	Value	Functional Range	Lab Range
Glucose	93	75 - 90	65 - 99
Hemoglobin A1c	5.4	4.4 - 5.4	4.8 - 5.6
Uric Acid	6.9	3.7 - 6.0	3.7 - 8.6
BUN	11	13 - 18	6 - 24
Creatinine	0.99	0.85 - 1.1	0.76 - 1.27
BUN/Creatinine Ratio	11	8 - 19	9 - 20
Sodium	145	135 - 140	134 - 144
Potassium	4.6	4.0 - 4.5	3.5 - 5.2
Chloride	104	100 - 106	97 - 108
CO2	25	25 - 30	18 - 29
Calcium	9.4	9.2 - 10.1	8.7 - 10.2
Phosphorus	2.7	3.5 - 4.0	2.5 - 4.5
Magnesium	2.0	2.0 - 2.6	1.6 - 2.3
Protein, total	6.8	6.9 - 7.4	6.0 - 8.5
Albumin	4.5	4.0 - 5.0	3.5 - 5.5
Globulin	2.3	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.0	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	141	140 - 180	121 - 224
AST	23	10 - 30	0 - 40
ALT	28	10 - 29	0 - 44
GGT	22	0 - 40	0 - 65
TIBC	290	275 - 425	250 - 450
UIBC	174	175 - 350	111 - 343
Iron	116	40 - 135	38 - 169
Iron saturation	40	17 - 45	15 - 55
Ferritin	222	30 - 100	30 - 400
Vitamin B-12	474	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	54.6	35 - 60	30.0 - 100.0
Cholesterol, total	180	150 - 240	100 - 199
Triglycerides	82	50 - 100	0 - 149
HDL	63	55 - 85	> 39
LDL	101	0 - 175	0 - 99
T. Chol / HDL Ratio	2.9	< 3	0 - 5.0
Triglycerides / HDL Ratio	1.30	< 2	< 3.8
CRP-hs	0.25	< 1.0	0.00 - 3.00
Homocysteine	14.5	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	2.960	0.5 – 2.5	0.45 - 4.50
T4, total	7.3	6.0 – 12	4.5 - 12
T3 Uptake	26	30 - 38	24 - 39
T3, Total	122	100 – 180	71 - 180
Copper	77		72 - 166
Zinc	80		56 - 134
Zinc / Copper Ratio	1.04	> 0.85	
Serum Methylmalonic Acid (MMA)	138	0 - 325	0 - 378
WBC	5.1	5.0 – 8.0	3.4 - 10.8
RBC	4.67	4.4 – 4.9	4.14 - 5.8
Hemoglobin	14.5	14 - 15	12.6 - 17.7
Hematocrit	41.9	40 - 48	37.5 - 51.0
MCV	90	85 – 92	79 - 97
MCH	31.0	27.7 – 32.0	26.6 - 33.0
MCHC	34.6	32 – 35	31.5 - 35.7
RDW	13.7	11.5 – 15.0	12.3 - 15.4
Platelets	202	150 – 415	150 - 379
Neutrophils	58	40 – 60	
Lymphocytes	32	25 – 40	
Monocytes	7	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

Fasting glucose is 93. Uric acid is functionally high at 6.0 but well within the lab range. Triglycerides are 82, which are fine. Blood sugar is probably not an issue given this, but it wouldn't be a bad idea to do some more advanced follow-up testing.

Sodium is slightly elevated out of the lab range at 145, and dehydration is the likeliest cause of this. Otherwise, there are a number of markers out of the functional range, but I don't think many are significant except for possibly ferritin of 222, which could be a marker for inflammation or iron overload because UIBC is slightly low in the functional range at 174, so you could redo an iron panel with ferritin there.

LDL cholesterol is two points above the lab range. I'm not concerned about this, especially with total cholesterol of 180, HDL of 63, and a total cholesterol-to-HDL ratio of 2.9, which is optimal.

Homocysteine is 14.5, which is almost out of the lab range, so quite high. Serum B12 is low-normal at 474. Serum MMA is normal, so I'd look at FIGLU and urine MMA.

TSH is 2.96, which is high-normal, as you know, in the functional range. Total T3 of 122 is pretty good, so I would do a more advanced thyroid panel and get free T4, free T3, and maybe thyroid antibodies.

For follow-up here, not a lot. I would retest iron panel, maybe add soluble transferrin receptor for clarity. Look at methylation, urine FIGLU, and urine MMA, as a start, and possibly do a functional methylation panel. Then, see if TSH comes down as you address any other pathologies that you discover in the case review, and if it doesn't, you could consider additional testing and treatment, or you could go ahead and do additional testing first.