

Blood Chemistry Review I - Part Two

Okay, the next patient is a 47-year-old female with chief complaint of gas, bloating, constipation, abdominal pain, hypotension, and brain fog.

Marker	Value	Functional Range	Lab Range
Glucose	92	75 - 90	65 - 99
Hemoglobin A1c	5.6	4.4 - 5.4	4.8 - 5.6
Uric Acid	3.0	3.2 - 5.5	2.5 - 7.1
BUN	13	13 - 18	6 - 24
Creatinine	0.58	0.7 - 1.0	0.57 - 1.00
BUN/Creatinine Ratio	22	9 - 23	9 - 23
eGFR if Non-African American	110		> 59
eGFR if African American	127		> 59
Sodium	137	135 - 140	134 - 144
Potassium	3.9	4.0 - 4.5	3.5 - 5.2
Chloride	101	100 - 106	97 - 108
CO2	23	25 - 30	18 - 29
Calcium	8.7	9.2 - 10.1	8.7 - 10.2
Parathyroid Hormone, Intact	28	30 - 60	15 - 65
Phosphorus	3.8	3.0 - 4.0	2.5 - 4.5
Magnesium	2.0	2.0 - 2.6	1.6 - 2.3
Protein, total	6.1	6.9 - 7.4	6.0 - 8.5
Albumin	4.1	4.0 - 5.0	3.5 - 5.5
Globulin	2.0	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.1	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.2	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	33	42 - 107	39 - 117
LDH	116	140 - 180	119 - 226
AST	12	10 - 23	0 - 40
ALT	9	10 - 20	0 - 32
GGT	10	5 - 21	0 - 60
TIBC	323	275 - 425	250 - 450
UIBC	290	175 - 350	131 - 425
Iron	33	40 - 135	27 - 159
Iron saturation	10	17 - 45	15 - 55
Ferritin	9	30 - 100	15 - 150
Vitamin B-12	369	450 - 2000	211 - 946
Folate, Serum	18.7	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	39.4	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	26.2	35 - 60	30.0 - 100.0
Cholesterol, total	179	150 - 250	100 - 199
Triglycerides	42	50 - 100	0 - 149
HDL	67	55 - 85	> 39
LDL	104	0 - 175	0 - 99
T. Chol / HDL Ratio	2.7	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.63	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	0.49	< 1.0	0.00 - 3.00
Homocysteine	6.7	< 7.0	0.0 - 15.0
TSH	1.530	0.5 - 2.5	0.45 - 4.500
T4, total	6.7	6.0 - 12	4.5 - 12.0
T3 Uptake	25	28 - 35	24 - 39
T3, Total	90	100 - 180	71 - 180
T3, Free	2.5	2.5 - 4.0	2 - 4.4
T4, Free	0.94	1 - 1.5	0.82 - 1.77
Reverse T3	14.1	9 - 21	9.2 - 24.1
Thyroid - TPO Ab	6		0 - 34
Thyroid - TGA	<1.0		0 - 0.9
Copper	82	81 - 157	72 - 166
Zinc	74	64 - 126	56 - 134
Zinc / Copper Ratio	0.90	> 0.85	
Serum Methylmalonic Acid (MMA)	198	< 300	0 - 378
WBC	4.6	5.0 - 8.0	3.4 - 10.8
RBC	3.76	4.4 - 4.9	3.77 - 5.28
Hemoglobin	11.2	13.5 - 14.5	11.1 - 15.9
Hematocrit	34.2	37 - 44	34 - 46.6
MCV	91	85 - 92	79 - 97
MCH	29.8	27.7 - 32.0	26.6 - 33.0
MCHC	32.7	32 - 35	31.5 - 35.7
RDW	13.9	11.5 - 15.0	12.3 - 15.4
Platelets	238	150 - 415	150 - 379
Neutrophils	54	40 - 60	
Lymphocytes	36	25 - 40	
Monocytes	5	4.0 - 7.0	
Eosinophils	4	0.0 - 3.0	
Basophils	1	0.0 - 3.0	

Fasting glucose is 92, and A1c is 5.6. Again, this could be nonpathological, or it could be early dysglycemia, so you need other markers such as postmeal glucose or fructosamine to help make that determination. Her LDH is low, which as you recall sometimes does happen in reactive hypoglycemia, so that is another stick on the pile suggesting dysglycemia.

Her 25(OH)D is lab-low at 26, and her serum calcium is borderline low at 8.7, but her PTH is 29, which is optimally suppressed. Given that, she is unlikely to be biologically deficiency in vitamin D, but given the equivocality of the markers, it wouldn't hurt to supplement a bit because you're not going to cause harm by supplementing at this lower level, and there is a chance that she is actually deficient given that calcium is almost out of the lab range.

Alkaline phosphatase is low at 33. I'm thinking thyroid or zinc. Zinc is low-normal at 74, in a range of 56 to 134. Zinc-to-copper ratio is adequate, though, at 0.9. TSH is optimal at 1.5, but total T3 and free T3 are low-normal in the functional range. In terms of the cause of low alkaline phosphatase, it could be either relatively low zinc, some thyroid issue, or both, or something else that we're not picking up on here.

Iron-deficiency anemia: She has low serum iron, low iron saturation of 10 percent, low ferritin of 9, and she has lab-low red blood cells of 3.76 and then functionally low, almost lab-low hemoglobin at 11.2 and hematocrit at 34.2.

Her B12 is low-normal at 369, but serum MMA is normal, and homocysteine is optimal, so unlikely to be deficient, but you could definitely look at urine MMA and FIGLU as a follow-up for both folate and B12 there.

For this patient, we would want to follow up on blood sugar, iron-deficiency anemia, thyroid and zinc status, and gut.

The next patient is a 40-year-old female with chief complaint of ulcerative colitis, diagnosed seven years prior to coming to see me. She currently has extreme GI issues, fatigue, and muscle and joint aches.

Marker	Value	Functional Range	Lab Range
Glucose	88	75 - 90	65 - 99
Hemoglobin A1c	5.7	4.4 - 5.4	4.8 - 5.6
Uric Acid	3.5	3.2 - 5.5	2.5 - 7.1
BUN	11	13 - 18	6 - 24
Creatinine	0.88	0.85 - 1.1	0.57 - 1.00
BUN/Creatinine Ratio	13	9 - 23	9 - 23
Sodium	136	135 - 140	134 - 144
Potassium	4.4	4.0 - 4.5	3.5 - 5.2
Chloride	99	100 - 106	97 - 108
CO2	21	25 - 30	18 - 29
Calcium	8.6	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.5	3.5 - 4.0	2.5 - 4.5
Magnesium	1.8	2.0 - 2.6	1.6 - 2.3
Protein, total	6.5	6.9 - 7.4	6.0 - 8.5
Albumin	4.2	4.0 - 5.0	3.5 - 5.5
Globulin	2.3	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.8	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.5	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	50	42 - 107	39 - 117
LDH	156	140 - 180	119 - 226
AST	13	10 - 30	0 - 40
ALT	9	10 - 22	0 - 32
GGT	8	< 13	0 - 60
TIBC	296	275 - 425	250 - 450
UIBC	128	175 - 350	131 - 425
Iron	168	40 - 135	27 - 159
Iron saturation	57	17 - 45	15 - 55
Ferritin	39	30 - 100	15 - 150
Vitamin B-12	272	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	29.9	35 - 60	30.0 - 100.0
Cholesterol, total	149	150 - 250	100 - 199
Triglycerides	54	50 - 100	0 - 149
HDL	73	55 - 85	> 39
LDL	65	0 - 175	0 - 99
T. Chol / HDL Ratio	2.0	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.74	< 2	< 3.8
CRP-hs	0.49	< 1.0	0.00 - 3.00
Homocysteine	13.2	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	1.570	0.5 – 2.5	0.45 - 4.500
T4, total	8.0	6.0 – 12	4.5 - 12.0
T3 Uptake	25	28 - 35	24 - 39
T3, Total	118	100 – 180	71 - 180
Copper	128		72 - 166
Zinc	80		56 - 134
Zinc / Copper Ratio	0.63	> 0.85	
Serum Methylmalonic Acid (MMA)	140	< 300	0 - 378
WBC	3.5	5.0 – 8.0	3.4 - 10.8
RBC	3.75	4.4 – 4.9	3.77 - 5.28
Hemoglobin	11.7	13.5 - 14.5	11.1 - 15.9
Hematocrit	36	37 - 44	34 - 46.6
MCV	96	85 – 92	79 - 97
MCH	31.2	27.7 – 32.0	26.6 - 33.0
MCHC	32.5	32 – 35	31.5 - 35.7
RDW	13.7	11.5 – 15.0	12.3 - 15.4
Platelets	213	150 – 415	150 - 379
Neutrophils	50	40 – 60	
Lymphocytes	33	25 – 40	
Monocytes	8	4.0 – 7.0	
Eosinophils	8	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

Fasting glucose is normal. A1c is 5.7. You could do postmeal blood sugars here, but it is likely that A1c is inaccurate given her anemia markers. Remember that anemia is one of the conditions that makes A1c inaccurate.

Her 25(OH)D is 29.9. Calcium is low at 8.6. We didn't have PTH at this time on her, but given the low calcium and the low 25(OH)D, it's likely that she is deficient. Magnesium is low at 1.8. Remember there is a very high likelihood at 1.7 and 1.8 that they are magnesium deficient. B12 is almost lab-low at 272. Homocysteine is high at 13.2, so that is suggestive of B12 deficiency. Red blood cells are lab-low at 3.75. Hemoglobin and hematocrit are functionally low, and then MCV is almost out of the lab range at 96. This is a pretty classic case of B12-deficient anemia, so this is a later stage of B12 deficiency.

This case illustrates why it is so important to run an iron panel, B12, and folate routinely. As we discussed in the anemia presentations, when most primary care providers see low hemoglobin, they automatically assume iron deficiency, and they prescribe iron supplements without even checking the iron panel. As you can see, that would be a very bad idea in this case because the patient, in fact, has iron overload. Iron saturation is 57 percent. Serum iron is high at 168. UIBC is low at 128. Ferritin is normal, although as we've discussed, that doesn't rule out iron overload. If you gave this patient iron supplements, you would make her worse.

You can also tell that anemia is due to B12 or folate deficiency because the MCV is almost out of the lab range, high rather than low, which it would be in iron deficiency. Zinc-to-copper ratio is low at 0.63. White blood cell is low-normal, and this may be the result of autoimmunity. Remember she

has ulcerative colitis. It is interesting here that CRP is normal. You might expect it not to be in someone with active ulcerative colitis, but it doesn't always correlate.

The next patient is a 45-year-old female with chief complaint of psoriasis and psoriatic arthritis with moderate progression in one toe. The onset was after delivery of her children about six years ago. She had gestational diabetes and has a strong family history of diabetes, and both parents recently died of complications that were related to diabetes, so she is very understandably concerned about a blood sugar disorder.

Marker	Value	Functional Range	Lab Range
Glucose	92	75 - 90	65 - 99
Hemoglobin A1c	5.8	4.4 - 5.4	4.8 - 5.6
Uric Acid	4.1	3.2 - 5.5	2.5 - 7.1
BUN	15	13 - 18	6 - 24
Creatinine	0.59	0.7 - 1.0	0.57 - 1
BUN/Creatinine Ratio	25	9 - 23	9 - 23
eGFR if Non-African American	111		> 59
eGFR if African American	128		> 59
Sodium	142	135 - 140	134 - 144
Potassium	4.2	4.0 - 4.5	3.5 - 5.2
Chloride	102	100 - 106	97 - 108
CO2	24	25 - 30	18 - 29
Calcium	10.3	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.4	3.0 - 4.0	2.5 - 4.5
Magnesium	2.0	2.0 - 2.6	1.6 - 2.3
Protein, total	7.1	6.9 - 7.4	6.0 - 8.5
Albumin	4.2	4.0 - 5.0	3.5 - 5.5
Globulin	2.9	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.4	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.3	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	52	42 - 107	39 - 117
LDH	102	140 - 180	119 - 226
AST	19	10 - 23	0 - 40
ALT	10	10 - 20	0 - 32
GGT	10	5 - 21	0 - 60
TIBC	316	275 - 425	250 - 450
UIBC	272	175 - 350	131 - 425
Iron	44	40 - 135	27 - 159
Iron saturation	14	17 - 45	15 - 55
Ferritin	70	30 - 100	15 - 150
Vitamin B-12	661	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	52.5	35 - 60	30.0 - 100.0
Cholesterol, total	148	150 - 250	100 - 199
Triglycerides	85	50 - 100	0 - 149
HDL	45	55 - 85	> 39
LDL	86	0 - 175	0 - 99
T. Chol / HDL Ratio	3.3	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.89	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	17.83	< 1.0	0.00 - 3.00
Homocysteine	8.7	< 7.0	0.0 - 15.0
TSH	5.270	0.5 - 2.5	0.45 - 4.50
T4, total	7.4	6.0 - 12	4.5 - 12
T3 Uptake	24	28 - 35	24 - 39
T3, Total	117	100 - 180	71 - 180
T3, Free	2.6	2.5 - 4.0	2 - 4.4
T4, Free	0.97	1 - 1.5	0.82 - 1.77
Thyroid - TPO Ab	12		0 - 34
Thyroid - TGA	114.4		0 - 0.9
Copper	193		72 - 166
Zinc	75		56 - 134
Zinc / Copper Ratio	0.39	> 0.85	
Serum Methylmalonic Acid (MMA)	104	< 300	0 - 378
WBC	6.6	5.0 - 8.0	3.4 - 10.8
RBC	4.48	4.4 - 4.9	3.77 - 5.28
Hemoglobin	11.6	13.5 - 14.5	11.1 - 15.9
Hematocrit	35.3	37 - 44	34 - 46.6
MCV	79	85 - 92	79 - 97
MCH	25.9	27.7 - 32.0	26.6 - 33.0
MCHC	32.9	32 - 35	31.5 - 35.7
RDW	13.4	11.5 - 15.0	12.3 - 15.4
Platelets	287	150 - 415	150 - 379
Neutrophils	57	40 - 60	
Lymphocytes	32	25 - 40	
Monocytes	5	4.0 - 7.0	
Eosinophils	5	0.0 - 3.0	
Basophils	1	0.0 - 3.0	
IA-2 Autoantibodies	<1.0		< 1
ZNT8 Antibodies	<15		< 15
GAD-65	<5.0		0 - 5
Antipancreatic Islet Cells	Negative		Negative

Her fasting glucose was 92, but her A1c was high at 5.8. She does have some anemia markers, so we can't rely on A1c, but given her slightly high fasting glucose and her family history, we did additional testing for autoimmune diabetes for her. We ran IA-2 autoantibodies; zinc transporter antibodies; glutamic acid decarboxylase, GAD65 antibodies; and antipancreatic islet cells. These were all negative.

Her BUN-to-creatinine ratio was high mostly because of low-normal creatinine, likely nonpathological. Serum calcium was high, just barely high here. Vitamin D is normal, and phosphorus was normal. We didn't have a parathyroid hormone level on this particular patient. I would definitely retest serum calcium, but I would also run ionized calcium, and I would run parathyroid hormone because it is possible that there is a hyperparathyroid situation here.

Note that CRP is also very high at 17.83, so there is some very significant inflammation happening there. We have a TSH of 5.2, which is frank hypothyroidism, with total T3 normal at 117 and free T3 at 2.6, which is at the low end of the optimal range, and then a free T3 of 0.97. Thyroglobulin antibodies were 115, which were elevated, so this patient does have autoimmunity, an autoimmune

thyroid condition. That was another reason why we decided to test her for autoimmune diabetes because patients with one autoimmune condition are more likely to have another.

The homocysteine was elevated at 8.7. Serum B12 was normal. Serum methylmalonic acid was normal, so you would want to be looking at urine FIGLU and urine MMA as a check to see what is slightly increasing the homocysteine levels. As mentioned before, she has some anemia markers. Hemoglobin is 11.6, almost out of the lab range. Hematocrit is 35.3. MCV is 79, which is low, almost out of the lab range low, and then her MCH actually is low.

Note that her iron saturation is 14 percent, so that is indicative of iron deficiency. It looks like she could have iron-deficiency anemia and possibly B12 or folate deficiency, and that might be contributing to the anemia as well as the slight elevation in homocysteine. Note that her zinc-to-copper ratio is 0.39, which is among the lowest that I've seen. I've seen 0.2, I think is the lowest, but again, serum copper elevation like this is typically a marker of inflammation, and that is no surprise given her very high C-reactive protein levels.

A lot going on here. We have dysglycemia, a blood sugar issue. We have possible hyperparathyroidism. We've got iron-deficiency anemia. We've got an autoimmune thyroid condition, which is involving significant inflammation. We've got impaired methylation. I didn't mention this before, but the LDH you see is also low, and remember that can happen with blood sugar dysregulation, so that is something we would want to follow up on and another reason to follow up on the blood sugar issue.

Okay, the next patient is a 44-year-old female. I'm going to read you what she wrote on the intake form because it's helpful, I think, to see exactly what patients say. She said, "I want to heal my adrenal fatigue and exercise-induced injuries by learning what treatment, diet, supplements, and exercise are best for my body. I'm currently seeing a naturopath, but it has been eight months now, and I'm still not better. They also don't make diet or exercise recommendations. I'd also like to lose the last 10 pounds I've been working on for the prior decade with no long-term success."

Marker	Value	Functional Range	Lab Range
Glucose	83	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	15	13 - 18	6 - 24
Creatinine	0.78	0.7 - 1.0	0.57 - 1.00
BUN/Creatinine Ratio	19	9 - 23	9 - 23
eGFR if Non-African American	93		> 59
eGFR if African American	107		> 59
Sodium	139	135 - 140	134 - 144
Potassium	4.4	4.0 - 4.5	3.5 - 5.2
Chloride	97	100 - 106	97 - 108
C02	23	25 - 30	18 - 29
Calcium	10.0	9.2 - 10.1	8.7 - 10.2
Parathyroid Hormone, Intact	21	30 - 60	15 - 65
Phosphorus	3.7	3.0 - 4.0	2.5 - 4.5
Magnesium	2.1	2.0 - 2.6	1.6 - 2.3
Protein, total	7.0	6.9 - 7.4	6.0 - 8.5
Albumin	4.9	4.0 - 5.0	3.5 - 5.5
Globulin	2.1	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.3	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.3	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	46	42 - 107	39 - 117
LDH	170	140 - 180	119 - 226
AST	23	10 - 23	0 - 40
ALT	17	10 - 20	0 - 32
GGT	7	5 - 21	0 - 60
TIBC	278	275 - 425	250 - 450
UIBC	221	175 - 350	131 - 425
Iron	57	40 - 135	27 - 159
Iron saturation	21	17 - 45	15 - 55
Ferritin	121	30 - 100	15 - 150
Vitamin B-12	>1999	450 - 2000	211 - 946
Folate, Serum	>20.0	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	55.9	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	79.8	35 - 60	30.0 - 100.0
Cholesterol, total	182	150 - 250	100 - 199
Triglycerides	53	50 - 100	0 - 149
HDL	71	55 - 85	> 39
LDL	100	0 - 175	0 - 99
T. Chol / HDL Ratio	2.6	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.75	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	0.41	< 1.0	0.00 - 3.00
Homocysteine	8.0	< 7.0	0.0 - 15.0
TSH	0.056	0.5 - 2.5	0.45 - 4.500
T4, total	9.7	6.0 - 12	4.5 - 12.0
T3 Uptake	29	28 - 35	24 - 39
T3, Total	144	100 - 180	71 - 180
T3, Free	3.9	2.5 - 4.0	2 - 4.4
T4, Free	1.55	1 - 1.5	0.82 - 1.77
Reverse T3	36.5	9 - 21	9.2 - 24.1
Thyroid - TPO Ab	8		0 - 34
Thyroid - TGA	<1.0		0 - 0.9
Copper	101		72 - 166
Zinc	98		56 - 134
Zinc / Copper Ratio	0.97	> 0.85	
Serum Methylmalonic Acid (MMA)	162	< 300	0 - 378
WBC	4.0	5.0 - 8.0	3.4 - 10.8
RBC	4.58	4.4 - 4.9	3.77 - 5.28
Hemoglobin	13.7	13.5 - 14.5	11.1 - 15.9
Hematocrit	42.3	37 - 44	34 - 46.6
MCV	92	85 - 92	79 - 97
MCH	29.9	27.7 - 32.0	26.6 - 33.0
MCHC	32.4	32 - 35	31.5 - 35.7
RDW	13.1	11.5 - 15.0	12.3 - 15.4
Platelets	251	150 - 415	150 - 379
Neutrophils	65	40 - 60	
Lymphocytes	29	25 - 40	
Monocytes	4	4.0 - 7.0	
Eosinophils	1	0.0 - 3.0	
Basophils	1	0.0 - 3.0	

In her blood work, at least, there is not a lot going on. Ferritin is borderline high at 121, but her iron markers are normal. Iron saturation is even toward the low end of the range. CRP is normal. Zinc-to-copper ratio is normal. Not a lot of markers of inflammation here, but check out her reverse T3. It is very high at 36.5. The upper end of the range is 24, so that is a marker of inflammation.

B12 is lab-high. The most likely reason is supplementation, but you always need to ask the patient to clarify. Remember that high serum B12 in the absence of supplementation can be a sign of dysfunctional B12 metabolism. Her 25(OH)D is also high here at 79.8. Given high B12, it is another hint that the patient might be supplementing.

TSH is almost 0; it's 0.056. Free T4 is borderline high at 1.55, and free T3 and total T3 are high-normal. Of course, this looks on the surface like hyperthyroidism, but you need to ask the patient if she is taking thyroid medication already to determine if it is factitious hyperthyroidism or if it is not. In this case, the patient was, in fact, taking 1.25 grains of Nature-Throid, and this was obviously too much for her.

This also illustrates an important point. She was probably prescribed Nature-Throid because of indications of hypothyroidism, whether symptoms or labs, but with the reverse T3 as high as she

has, it is possible that the issue wasn't thyroid related but inflammation. In terms of possible causes of elevated reverse T3, she had herpes simplex with lesions more frequently in her 20s. She reports that they are now pretty rare, only once about every two years, but over the past year, she had two to three outbreaks and was currently taking valacyclovir. It's possible that a reactivated viral infection here is causing this elevation of reverse T3 and inflammatory picture.