KRESSER INSTITUTE
FOR FUNCTIONAL AND EVOLUTIONARY MEDICINE

Blood Chemistry Review I - Part One

Hey, everybody. This week we're going to review some full blood chemistry panels, and I just picked a few patients at random because I want to show you a typical sampling of patients from my everyday practice. I haven't selected these panels to demonstrate any particular issue.

Okay, so the first patient is a 33-year-old female with chief complaint of digestive issues, starting as far back as second grade. She currently has diarrhea, but she has previously suffered from constipation. She has joint pain, recent increase in fasting glucose and hemoglobin A1c, mercury dental amalgams, headaches, brain fog, and decreased cognitive function.

Marker	Value	Functional Range	Lab Range
Glucose	96	75 - 90	65 - 99
Hemoglobin A1c	5.8	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.4	3.2 - 5.5	2.5 - 7.1
BUN	9	13 – 18	6 - 20
Creatinine	0.67	0.7 – 1.0	0.57 - 1
BUN/Creatinine Ratio	13	9 – 23	8 - 20
eGFR if Non-African American	116		> 59
eGFR if African American	134		> 59
Sodium	139	135 – 140	134 - 144
Potassium	4.0	4.0 – 4.5	3.5 - 5.2
Chloride	100	100 – 106	97 - 108
C02	19	25 – 30	18 - 28
Calcium	8.7	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.7	3.0 – 4.0	2.5 - 4.5
Magnesium	1.9	2.0 – 2.6	1.6 - 2.3
Protein, total	6.6	6.9 – 7.4	6.0 - 8.5
Albumin	4.3	4.0 – 5.0	3.5 - 5.5
Globulin	2.3	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.9	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.5	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	36	42 – 107	39 - 117
LDH	125	140 - 180	119 - 226
AST	15	10 - 23	0 - 40
ALT	7	10 - 20	0 - 32
GGT	8	5 - 21	0 - 60
TIBC	277	275 – 425	250 - 450
UIBC	122	175 - 350	131 - 425
Iron	155	40 – 135	27 - 159
Iron saturation	56	17 – 45	15 - 55
Ferritin	61	30 - 100	15 - 150
Vitamin B-12	636	450 – 2000	211 - 946
Vitamin D, 25-hydroxy	29	35 - 60	30.0 - 100.0
Cholesterol, total	202	150 - 250	100 - 199
Triglycerides	50	50 – 100	0 - 149
HDL	75	55 – 85	> 39
LDL	117	0 - 175	0 - 99
T. Chol / HDL Ratio	2.7	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.67	< 2	< 3.8
CRP-hs	0.2	< 1.0	0.00 - 3.00
Homocysteine	7.0	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	2.200	0.5 – 2.5	0.45 - 4.50
T4, total	6.5	6.0 – 12	4.5 - 12
T3 Uptake	33	28 - 35	24 - 39
T3, Total	97	100 – 180	71 - 180
Copper	98		72 - 166
Zinc	71		56 - 134
Zinc / Copper Ratio	0.72	> 0.85	
Serum Methylmalonic Acid (MMA)	199	< 300	0 - 378
WBC	5.5	5.0 – 8.0	3.4 - 10.8
RBC	4.26	4.4 – 4.9	3.77 - 5.28
Hemoglobin	13.5	13.5 - 14.5	11.1 - 15.9
Hematocrit	40.6	37 - 44	34 - 46.6
MCV	95	85 – 92	79 - 97
MCH	31.7	27.7 – 32.0	26.6 - 33.0
MCHC	33.3	32 – 35	31.5 - 35.7
RDW	13.6	11.5 – 15.0	12.3 - 15.4
Platelets	303	150 – 415	150 - 379
Neutrophils	54	40 – 60	
Lymphocytes	35	25 – 40	
Monocytes	7	4.0 – 7.0	
Eosinophils	3	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

Her fasting glucose is 96, and her A1c is 5.8, so this definitely suggests there could be an issue with blood sugar. Her magnesium is low-normal at 1.9, and that might be related to blood sugar issues, as you know from the ADAPT content. Her 25(OH)D is low-normal at 29, and this was before I was routinely running parathyroid hormone as a check, so you may want to do that in this situation to determine if she actually has biological vitamin D deficiency or just normally low levels, especially because this patient is of East Asian descent. If you recall from the vitamin D unit, patients of East Asian descent do typically have lower D levels, and that is not necessarily pathological. Her alkaline phosphatase is low at 36. Remember the possible causes here most commonly are hypothyroidism or zinc deficiency. Her zinc is low-normal, and her zinc-to-copper ratio is low-normal at 0.72, so that may be what is going on here. Her TSH is high-normal at 2.2 and T3 is low-normal, so it could be both hypothyroidism and low zinc in this case. I would run free T4, free T3, and thyroid antibodies in this case and also repeat TSH.

She has mild iron overload. Her UIBC, which is one of the more sensitive markers, is low at 122, and her iron saturation is high at 56 percent. Serum iron is borderline high, almost out of the lab range at 155. Note that her ferritin is normal, but recall from the iron overload unit that ferritin can sometimes be normal in cases of iron overload.

Total cholesterol is marked high here at 202, but it's only three points out of the lab range. I don't think this is significant or any cause for concern, especially because her triglycerides are optimal at 50 and her HDL is optimal at 75.

You can see here there are a few other markers that are out of the functional range such as BUN, creatinine, red blood cells, and MCV. I'm not mentioning these because they don't comprise a pattern. Remember, one marker out of the functional range alone is usually not a concern.

The main issues here would be iron overload, magnesium, vitamin D, and blood sugar dysregulation, and you would need to follow up with these to get more information, particularly on the blood sugar issue because she has been on a Paleo-type diet for a few years, so she is not eating a lot of processed and refined carbohydrates or inflammatory foods that would contribute to this. That would be an important next step.

The next patient is a 71-year-old female. Chief complaint, in her words, was "SIBO, leaky gut, and Candida." Just an interjection here. You will have patients coming in complaining about leaky gut and Candida even though they have never been tested for either of those things just based on their internet research. Continuing here, in her words, "histamine intolerance, arthritis, eczema, brain fog, anxiety, mild depression, and on and on." She has a lot going on.

Marker	Value	Functional Range	Lab Range
Glucose	91	75 - 90	65 - 99
Hemoglobin A1c	5.8	4.4 – 5.4	4.8 - 5.6
Uric Acid	3.8	3.2 - 5.5	2.5 - 7.1
BUN	12	13 – 18	8 - 27
Creatinine	0.64	0.7 – 1.0	0.57 - 1
BUN/Creatinine Ratio	19	9 – 23	11 - 26
eGFR if Non-African American	90		> 59
eGFR if African American	104		> 59
Sodium	135	135 – 140	134 - 144
Potassium	3.9	4.0 – 4.5	3.5 - 5.2
Chloride	95	100 – 106	97 - 108
C02	22	25 – 30	18 - 29
Calcium	8.6	9.2 – 10.1	8.7 - 10.3
Parathyroid Hormone, Intact	39	30 - 60	15 - 65
Phosphorus	3.4	3.0 – 4.0	2.5 - 4.5
Magnesium	2.0	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 - 4.8
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	63	42 – 107	39 - 117
LDH	152	140 - 180	119 - 226
AST	21	10 - 23	0 - 40
ALT	16	10 - 20	0 - 32
GGT	11	5 - 21	0 - 60
TIBC	246	275 – 425	250 - 450
UIBC	188	175 - 350	118 - 369
Iron	58	40 – 135	27 - 139
Iron saturation	24	17 – 45	15 - 55
Ferritin	235	30 - 100	15 - 150
Vitamin B-12	252	450 – 2000	211 - 946
Folate, Serum	18.4	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	54.7	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	28.6	35 - 60	30.0 - 100.0
Cholesterol, total	202	150 - 250	100 - 199
Triglycerides	39	50 – 100	0 - 149
HDL	68	55 – 85	> 39
LDL	126	0 - 175	0 - 99
T. Chol / HDL Ratio	3.0	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.57	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	2.19	< 1.0	0.00 - 3.00
Homocysteine	12.5	< 7.0	0.0 - 15.0
TSH	2.180	0.5 – 2.5	0.45 - 4.50
T4, total	7.6	6.0 – 12	4.5 - 12
T3 Uptake	32	28 - 35	24 - 39
T3, Total	79	100 – 180	71 - 180
T3, Free	2.2	2.5 - 4.0	2 - 4.4
T4, Free	1.23	1 - 1.5	0.82 - 1.77
Reverse T3	17.3	9 - 21	9.2 - 24.1
Thyroid – TPO Ab	<6		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
Copper	112	81 - 157	72 - 166
Zinc	68	64 - 126	56 - 134
Zinc / Copper Ratio	0.61	> 0.85	
Serum Methylmalonic Acid (MMA)	256	< 300	0 - 378
WBC	6.1	5.0 – 8.0	3.4 - 10.8
RBC	3.77	4.4 – 4.9	3.77 - 5.28
Hemoglobin	11.8	13.5 - 14.5	11.1 - 15.9
Hematocrit	34.4	37 - 44	34 - 46.6
MCV	91	85 – 92	79 - 97
MCH	31.3	27.7 – 32.0	26.6 - 33.0
MCHC	34.3	32 – 35	31.5 - 35.7
RDW	13.3	11.5 – 15.0	12.3 - 15.4
Platelets	307	150 – 415	150 - 379
Neutrophils	63	40 – 60	
Lymphocytes	28	25 – 40	
Monocytes	8	4.0 – 7.0	
Eosinophils	1	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

Fasting glucose was 91. A1c is 5.8. You would need postmeal blood sugar and perhaps fructosamine to determine whether there is a problem here. As you know, high A1c on its own is not necessarily a reliable indicator of dysglycemia. Her serum calcium is low. Remember that abnormal serum calcium levels typically are not related to calcium intake. They are more often a sign of vitamin D status. In this case, her 25(OH)D is low at 29, and her PTH is above 30 at 39, so this does suggest deficiency, especially when you put low calcium into the mix as well.

Her ferritin is high at 234, and TIBC is low, which suggests possible iron overload, yet iron saturation is at the low end of the range at 24. Serum iron is also low end of normal at 58. I would run soluble transferrin receptor in this case, especially because her CRP is a little high at 2.19, so it could be that the ferritin elevation is because of inflammation and not iron overload. In fact, that is what I would suspect given her high CRP, her low zinc-to-copper ratio, and her high homocysteine, all of which are inflammatory markers.

Her total cholesterol is very slightly out of the lab range at 202, again, not a primary concern here because her triglycerides are 39 and her HDL is 68. Homocysteine, again, is high at 12.5. This is suggestive of a B12 or folate deficiency and impaired methylation. We go over and we look at B12, and we see that it is almost lab-low at 252, with 211 being the low end of the range. Serum folate is

normal, quite high, actually, at 18.4, so this is likely B12 deficiency. It is probably later-stage B12 deficiency because it is showing up in the red blood cell indices with low red blood cells, low hemoglobin, and low hematocrit. Interestingly enough, her MCV is normal, although it is toward the higher end of the range. Especially with a patient who is 71 years old, you have to be thinking about B12 deficiency. It is very common in this population, in part because things such as SIBO and H. pylori become more common as we age, but there are numerous studies showing that B12 deficiency is very common and often undiagnosed or misdiagnosed in elderly populations, so it should always be on your mind.

Her TSH is slightly above the optimal range at 2.18. This is when I was using a slightly higher functional range. Her total T3 and free T3 are low-normal, so there is some thyroid hypofunction here, particularly under-conversion of T4 to T3. Her zinc-to-copper ratio again is low at 0.61. That is quite low, and along with CRP of 2.19, that is suggestive of inflammation.

For further workup, we would want to determine the source of inflammation. I would bet it is gut and probably SIBO and/or H. pylori, given her B12 deficiency and her symptoms, and also the low vitamin D levels could be part of that picture. We would want to restore her B12 levels, address anemia, and then retest thyroid after addressing gut and inflammation to see if it is still out of range or if the thyroid abnormalities were secondary to these other problems.

Marker	Value	Functional Range	Lab Range
Glucose	85	75 - 90	65 - 99
Hemoglobin A1c	5.2	4.4 – 5.4	4.8 - 5.6
Uric Acid	6.0	3.7 – 6.0	3.7 - 8.6
BUN	19	13 – 18	6 - 20
Creatinine	1.01	0.85 – 1.1	0.76 - 1.27
BUN/Creatinine Ratio	19	8 – 19	8 - 19
eGFR if Non-African American	101		> 59
eGFR if African American	117		> 59
Sodium	142	135 – 140	134 - 144
Potassium	4.4	4.0 – 4.5	3.5 - 5.2
Chloride	101	100 – 106	97 - 108
C02	24	25 – 30	18 - 29
Calcium	9.4	9.2 – 10.1	8.7 - 10.2
Parathyroid Hormone, Intact	78	30 - 60	15 - 65
Phosphorus	4.1	3.0 – 4.0	2.5 - 4.5
Magnesium	2.1	2.0 – 2.6	1.6 - 2.3
Protein, total	7.1	6.9 – 7.4	6.0 - 8.5
Albumin	4.6	4.0 – 5.0	3.5 - 5.5
Globulin	2.5	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.8	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.7	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	84	42 – 107	39 - 117
LDH	140	140 - 180	121 - 224
AST	22	0 - 25	0 - 40
ALT	23	0 - 26	0 - 44
GGT	10	0 - 29	0 - 65
TIBC	246	275 – 425	250 - 450
UIBC	172	175 - 350	111 - 343
Iron	74	40 – 135	38 - 169
Iron saturation	30	17 – 45	15 - 55
Ferritin	87	30 - 200	30 - 400
Vitamin B-12	369	450 – 2000	211 - 946
Folate, Serum	12.5	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	87.1	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	32.7	35 - 60	30.0 - 100.0
Cholesterol, total	160	150 - 240	100 - 199
Triglycerides	54	50 – 100	0 - 149
HDL	50	55 – 85	> 39
LDL	99	0 - 175	0 - 99
T. Chol / HDL Ratio	3.2	< 3	0 - 5.0
Triglycerides / HDL Ratio	1.08	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	0.49	< 1.0	0.00 - 3.00
Homocysteine	10.9	< 7.0	0.0 - 15.0
TSH	2.050	0.5 – 2.0	0.45 - 4.50
T4, total	6.5	6.0 – 12	4.5 - 12
T3 Uptake	30	30 - 38	24 - 39
T3, Total	79	100 – 180	71 - 180
T3, Free	2.7	2.5 - 4.0	2 - 4.4
T4, Free	1.3	1 - 1.5	0.82 - 1.77
Reverse T3	17.3	9 - 21	9.2 - 24.1
Thyroid – TPO Ab	9		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
Copper	79	81 - 157	72 - 166
Zinc	90	64 - 126	56 - 134
Zinc / Copper Ratio	1.14	> 0.85	
Serum Methylmalonic Acid (MMA)	207	< 300	0 - 378
WBC	4.7	5.0 – 8.0	3.4 - 10.8
RBC	4.99	4.4 – 4.9	4.14 - 5.8
Hemoglobin	14.9	14 - 15	12.6 - 17.7
Hematocrit	45.4	40 - 48	37.5 - 51.0
MCV	91	85 – 92	79 - 97
MCH	29.9	27.7 – 32.0	26.6 - 33.0
MCHC	32.8	32 – 35	31.5 - 35.7
RDW	13.7	11.5 – 15.0	12.3 - 15.4
Platelets	201	150 – 415	150 - 379
Neutrophils	51	40 – 60	
Lymphocytes	37	25 – 40	
Monocytes	8	4.0 – 7.0	
Eosinophils	4	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

The next patient is a 27-year-old male with chief complaint of gut dysbiosis. Again, here we see the value of using parathyroid hormone and screening for biological vitamin D deficiency. A 25(OH)D is low-normal at 32, but check out PTH. It is 78, which is well outside of the lab range, definitely not optimally suppressed. That is indicative of vitamin D deficiency. Calcitriol is lab-high at 87.1. Calcitriol can be a little confusing because, if you recall, it can be low, normal, or high in vitamin D deficiency. It can also be high in vitamin D toxicity. We can't make any prediction based on the value of calcitriol alone, but we can say that it is often out of whack when vitamin D is either low or high, and that is certainly happening here.

When parathyroid hormone is high, of course, you're thinking about hyperparathyroidism, but elevated calcium will be a typical finding in that situation. Here, calcium is actually low, or at least low-normal, so that is more a sign of vitamin D deficiency than it is of hyperparathyroidism. You could run ionized calcium, which is a more accurate way of assessing calcium values, to double-check, but in this situation, given the low 25(OH)D and the other markers, I would be inclined to supplement with vitamin D and see what happens with the parathyroid hormone. If it comes down, then it means it wasn't hyperparathyroidism, and it was just vitamin D deficiency, and that is, in fact, what happened here.

Homocysteine is high-normal at 10.9. Serum folate is adequate, more than adequate at 12.5. His B12 is low-normal at 369. Serum MMA is normal, but given the low serum B12, this is more likely to be B12 deficiency than folate deficiency, but I would also check urine FIGLU and MMA to get some other markers.

TSH is very, very slightly functionally high here at 2.05. On its own, I probably wouldn't be concerned about that, but the total T3 is also low-normal. Free T3, on the other hand, is 2.7, which is pretty good. It's very possible that there is no issue with thyroid at all, but I would track this as you go through the treatment. It definitely would not be something I would address right off the bat.

Serum copper is low-normal. Copper deficiency is a possibility here. It's hard to tell, as you know, with serum copper, so the best course of action is to recommend foods that are high in both zinc and copper.

White blood cells, red blood cells, monocytes, and eosinophils are slightly out of the functional range, but I don't think enough to comprise a pattern here or be significant. The main issues with this patient, again, are a nutrient deficiency, B12, vitamin D, and possibly copper. You would obviously check gut because that could be a cause of the nutrient imbalance or malabsorption, and also that is his main complaint.