KRESSER INSTITUTE FOR FUNCTIONAL AND EVOLUTIONARY MEDICINE

Other Metabolic Patterns - Part Two

Let's look at a case. This patient is a 43-year-old male with a strong family history of heart disease. We talked about him in the kidney disease presentation. His chief complaint was that he is overweight. He has fatigue, low exercise tolerance, and then also had gout and heart disease risk.

Marker	Value	Functional Range	Lab Range
Glucose	77	75 – 85	65 – 99
Hemoglobin A1c	5.5	4.4 – 5.4	4.8 – 5.6
Uric Acid	9.4	M: 3.7 – 6.0	3.7 – 8.6
BUN	19	13 – 18	6 – 24
Creatinine	1.31	0.85 – 1.1	0.76 – 1.27
Sodium	140	135 – 140	134 – 144
Potassium	4.4	4.0 – 4.5	3.5 – 5.2
Chloride	99	100 – 106	97 – 108
C02	25	25 – 30	18 - 29
Calcium	10.0	9.2 – 10.1	8.7 – 10.2
Phosphorus	2.0	3.5 – 4.0	2.5 – 4.5
Magnesium	2.0	2.0 – 2.5	1.6 – 2.6
Protein, total	6.4	6.9 – 7.4	6.0 – 8.5
Albumin	4.7	4.0 – 5.0	3.5 – 5.5
Globulin	1.7	2.4 – 2.8	1.5 – 4.5
A/G ratio	2.8	1.5 – 2.0	1.1 – 2.5
Bilirubin, total	0.6	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	71	42 – 107	39 - 117
LDH	215	140 - 180	0 – 225
AST	37	M: 10-30	0 – 40
ALT	42	M: 10-29	0 – 44
GGT	37	10 -26	0 -65
TIBC	330	250 – 350	250 – 450
UIBC	195	150 - 375	150 – 375
Iron	135	85 – 135	40 – 155
Iron saturation	41	15 – 40	15 – 55
Ferritin	534	M: 33-100	30 – 400
Cholesterol, total	255	150 – 250	100 – 199
Triglycerides	148	50 – 100	0 – 149
HDL	52	55 – 85	› 39
LDL	173	0 – 175	0 – 99
Triglycerides / HDL Ratio	2.846	‹ 2	‹ 3.8
TSH	1.960	0.5 – 2.5	0.450 – 4.50
T4, total	6.3	6.0 – 12	4.5 – 12.0
T3 Uptake	31	M: 30-38	24 – 39
T3, Total	91	100 – 180	71 – 180
Vitamin D, 25-hydroxy	18.7	35 - 60	30.0 - 100.0
WBC	7.7	5.0 – 8.0	3.4 - 10.8
RBC	4.83	4.4 – 4.9	4.14– 5.80
Hemoglobin	14.5	M: 14-15	12.6 - 17.7

	Value	Functional Range	Lab Range
Hematocrit	42.9	M: 40-48	37.5 - 51.0
MCV	89	85 – 92	79 - 97
MCH	30.0	27.7 – 32.0	26.6 - 33.0
MCHC	33.8	32 – 35	31.5 - 35.7
RDW	13.6	11.5 – 15.0	12.3 - 15.4
Platelets	239	150 – 415	150 – 379
Neutrophils	77	40 – 60	40 -74
Lymphocytes	14	25 – 40	14 – 46
Monocytes	8	4.0 – 7.0	4 - 12
Eosinophils	1	0.0 – 3.0	0 - 5
Basophils	0	0.0 – 3.0	0 - 3
B-12	450	450 – 2000	211 - 946
Additional Tests:			
CRP-hs	0.53		0.00 – 3.00
Homocysteine	9.7		0.00 – 15.0
Sed Rate (Westergren)	2		0 – 15
T3, Free			2.0 – 4.4
T4, Free			0.82 – 1.77
NMR – LDL-P	2902		< 1000
NMR – LDL-C	169		< 100
HDL-C	49		>= 40
Triglycerides	157		< 150
Cholesterol, Total	249		< 200
HDL-P (Total)	35.7		>= 30.5
Small LDL-P	1124		<= 527
LDL Size	20.5		> 20.5
LP-IR Score	70		<= 45
LP(a)	277		< 75
Lp-PLA2	196		131 – 199

Uric acid is high at 9.4. BUN is functionally high at 19, and RBC and hemoglobin are normal. He has several markers related to metabolic dysfunction: high ferritin, low vitamin D, functionally high LDH, AST, ALT, GGT, A1c, and triglycerides, and then functionally low HDL. He also had a very high LDL particle number, small LDL-P, and lipoprotein(a), and then a lipoprotein insulin resistance score of 70, which are all strongly indicative of metabolic dysfunction.

This patient also had low cortisol, high lysozyme, lactoferrin, and other markers of inflammation, despite a normal CRP on this blood test.

Marker	Value	Functional Range	Lab Range
Glucose	88	75 – 85	65 – 99
Hemoglobin A1c	5.5	4.4 – 5.4	4.8 – 5.6
Uric Acid	6.9	M: 3.7 – 6.0	3.7 – 8.6
BUN	22	13 – 18	6 – 24
Creatinine	0.96	0.85 – 1.1	0.76 – 1.27
Sodium	140	135 – 140	134 – 144
Potassium	4.2	4.0 – 4.5	3.5 – 5.2
Chloride	101	100 – 106	97 – 108
C02	24	25 – 30	19 - 28
Calcium	9.5	9.2 – 10.1	8.7 – 10.2
Phosphorus	2.9	3.5 – 4.0	2.5 – 4.5
Magnesium	2.0	2.0 – 2.5	1.6 – 2.6
Protein, total	7.0	6.9 – 7.4	6.0 – 8.5
Albumin	4.8	4.0 – 5.0	3.5 – 5.5
Globulin	2.2	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	69	42 - 107	39 - 117
LDH	156	140 - 180	0 – 225
AST	19	10 - 26	0 – 40
ALT	18	10 – 26	0 – 44
GGT	16	10 -26	0 - 65
TIBC	318	250 – 350	250 – 450
UIBC	203	150 - 375	150 – 375
Iron	115	85 – 135	40 – 155
Iron saturation	36	15 – 40	15 – 55
Ferritin	157	M: 33-100	30 – 400
Cholesterol, total	294	150 – 250	100 – 199
Triglycerides	173	50 – 100	0 – 149
HDL	56	55 – 85	› 39
LDL	203	0 – 175	0 – 99
Triglycerides / HDL Ratio	3.089	‹ 2	‹ 3.8
TSH	2.080	0.5 - 2.5	0.450 – 4.500
T4, Total	7.6	6.0 – 12	4.5 – 12.0
T3 Uptake	33	M: 30-38	24 – 39
T3, Total	97	100 – 180	71 – 180
Vitamin D, 25-hydroxy	40.7	35 - 60	30.0 – 100.0
WBC	8.3	5.0 – 8.0	3.4 - 10.8
RBC	5.22	4.4 – 4.9	4.14 - 5.80
Hemoglobin	14.7	M: 14-15	12.6 – 17.7

Marker	Value	Functional Range	Lab Range
Hematocrit	44.8	M: 40-48	37.5 - 51.0
MCV	86	85 – 92	79 - 97
MCH	28.2	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	197	150 – 415	155 - 379
Neutrophils	40	40 – 60	40 -74
Lymphocytes	49	25 – 40	14 – 46
Monocytes	8	4.0 – 7.0	4 - 12
Eosinophils	3	0.0 – 3.0	0 - 5
Basophils	0	0.0 – 3.0	0 - 3
B-12	924	450 – 2000	211 - 946
Additional Tests:			

The next patient is a 51-year-old male with chief complaints of low libido, fatigue, and occasional gout. Uric acid is high in the functional range of 6.9. BUN and RBC are also high in the functional range, which makes dehydration likely. There is no evidence of metabolic dysfunction in this case, but he did have low cortisol, and cortisol is an anti-inflammatory hormone. He also had low levels of vitamin C on the Great Plains Lab urine organic acid test. In this case, addressing vitamin C deficiency and hydrating adequately dramatically reduced the incidence and frequency of his gout attacks.

Treatment of gout primarily involves reducing inflammation. Diet is always the first consideration. A Paleo template is a great choice with plenty of antioxidant-rich fruits and vegetables, avoiding excess liquid fructose and industrial seed oils. Addressing any underlying pathologies you discover, of course, in the case review workup that can promote inflammation. You can also try high-dose vitamin C, which is nontoxic, cheap, and has little downside. Make sure the patient is adequately hydrated, especially if they have markers of dehydration, and we'll talk more about that next. It's probably best for the patient to abstain from alcohol, especially during a gout attack. Finally, blood donation, even in people with borderline high iron levels, may help.

The next pattern is dehydration. On the one hand, the idea that everyone needs to drink eight to 10 glasses of water a day is not supported by scientific evidence. Like so many other nutrition recommendations, it appears that individual needs for water vary widely, and 65 ounces of pure water every day may actually be too much for some people. There is no universal requirement for water intake, and your needs will vary widely based on age, gender, body size, health status, and

physical activity levels. Numerous environmental factors such as high temperature and humidity will, of course, also influence water needs.

It is difficult to estimate the exact amount of water needed for each individual, so thirst should be used as a general guideline for most people. In other words, if you're thirsty, drink, and if you're not thirsty, don't force yourself to drink simply because you believe it to be a healthy practice. In addition, the eight-cups-a-day recommendation typically doesn't account for the water content of food, which can be quite high, and many Paleo staples are surprisingly high in water besides just fruit and vegetables, which are the obvious ones. Foods such as salmon, eggs, potatoes, and yogurt, if the patient tolerates dairy, are about 75 percent water. Four ounces of broiled salmon, for example, provides about one-half cup of water. There are the more obvious foods such as watermelon and grapefruit, which are over 90 percent water.

All of that said, there is no question that adequate hydration is important, as water is a critical nutrient, and dehydration is a real issue with potentially serious consequences. Imagine a hypothetical person who drinks coffee throughout the day, doesn't drink much water or consume foods that are high in water, and sweats a lot. That person is definitely at risk for dehydration. Frequent diarrhea is also a risk factor for chronic dehydration, so in patients with inflammatory bowel disease, Crohn's, or ulcerative colitis, for example. Some populations such as children and teenagers and people with diabetes are especially vulnerable to the effects of dehydration.

Markers to consider for dehydration

Marker	Level
BUN	High
Carbon dioxide	High
RBC	High
HGB	High
HCT	High
Sodium	High
Potassium	Low

As with gout, in many cases, these markers that you would think about for dehydration won't actually be out of the lab range. They'll just be out of the functional range, although in the case of

BUN, RBC, hemoglobin, and carbon dioxide, they can actually be out of the lab range. These are the markers you would want to consider here.

Marker	Value	Functional Range	Lab Range
Glucose	85	75 – 85	65 – 99
Hemoglobin Alc	5.8	4.4 – 5.4	4.8 – 5.6
Uric Acid	5.9	M: 3.7 – 6.0	3.7 – 8.6
BUN	15	13 – 18	6 – 20
Creatinine	1.00	0.85 – 1.1	0.76 – 1.27
Sodium	139	135 – 140	134– 144
Potassium	4.5	4.0 – 4.5	3.5 – 5.2
Chloride	99	100 – 106	97 – 108
C02	28	25 – 30	18 - 29
Calcium	9.6	9.2 – 10.1	8.7 – 10.2
Phosphorus	3.2	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	4.7	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	0.8	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	53	42 – 107	39 - 117
LDH	148	140 - 180	0 – 225
AST	20	M: 10-30	0 – 40
ALT	18	M: 10-29	0 – 44
GGT	14	10 -26	0 -65
TIBC	291	250 – 350	250 – 450
UIBC	109	150 - 375	150 – 375
Iron	182	85 – 135	40 – 155
Iron saturation	63	15 – 40	15 – 55
Ferritin	208	M: 33-100	30 – 400
Cholesterol, total	208	150 – 250	100 – 199
Triglycerides	83	50 – 100	0 – 149
HDL	60	55 – 85	› 39
LDL	131	0 – 175	0 – 99
Triglycerides / HDL Ratio	1.383	‹ 2	‹ 3.8
TSH	2.560	0.5 – 2.5	0.450 – 4.50
T4, total	7.1	6.0 – 12	4.5 – 12.0
T3 Uptake	33	M: 30-38	24 – 39
T3, Total	122	100 – 180	71 – 180
Vitamin D, 25-hydroxy	42.7	35 - 60	30.0 – 100.0
WBC	5.2	5.0 – 8.0	3.4 - 10.8
RBC	5.92	4.4 – 4.9	4.10 – 5.6
Hemoglobin	17.3	M: 14-15	12.6– 17.7

	Value	Functional Range	Lab Range
Hematocrit	52.8	M: 40-48	37.5 - 51.0
MCV	89	85 – 92	79 - 97
MCH	29.2	27.7 – 32.0	26.6 - 33.0
MCHC	32.8	32 – 35	31.5 - 35.7
RDW	13.5	11.5 – 15.0	12.3 - 15.4
Platelets	173	150 – 415	150 – 379
Neutrophils	70	40 – 60	40 -74
Lymphocytes	18	25 – 40	14 – 46
Monocytes	8	4.0 – 7.0	4 - 12
Eosinophils	3	0.0 – 3.0	0 - 5
Basophils	1	0.0 – 3.0	0 - 3
B-12	475	450 – 2000	211 - 946
Additional Tests:			
CRP-hs	0.30		0.00 – 3.00
Homocysteine	9.0		0.00 – 15.0
Sed Rate (Westergren)	2		0 – 15
T3, Free			2.0 – 4.4
T4, Free			0.82 – 1.77

A couple cases. This patient is a 36-year-old male with chief complaint of hypogonadism, microprolactinoma, fatigue, and mood imbalance. RBC and hematocrit are out of the lab range, high, and hemoglobin is out of the functional range. BUN, sodium, and potassium are completely normal.

Note that he has iron overload. Remember from that unit that iron overload can cause elevations in RBC, hemoglobin, and hematocrit, so that is likely what is going on here, not dehydration.

Marker	Value	Functional Range	Lab Range
Glucose	124	75 – 90	65 - 99
Hemoglobin A1c	6.4	4.4 – 5.4	4.8 - 5.6
Uric Acid	6.0	3.2 - 5.5	2.5 - 7.1
BUN	15	13 – 18	8 - 27
Creatinine	0.56	0.85 – 1.1	0.57 - 1
Sodium	142	135 – 140	134 - 144
Potassium	4.3	4.0 – 4.5	3.5 - 5.2
Chloride	104	100 – 106	97 - 108
C02	20	25 – 30	18 - 29
Calcium	9.2	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.9	3.5 – 4.0	2.5 - 4.5
Magnesium	1.9	2.0 – 2.6	1.6 - 2.6
Protein, total	6.7	6.9 – 7.4	6.0 - 8.5
Albumin	4.5	4.0 – 5.0	3.6 - 4.8
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	0.5	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	118	42 – 107	39 - 117
LDH	178	140 - 180	119 - 226
AST	21	10 - 30	0 - 40
ALT	23	10 - 22	0 - 32
GGT	13	0 - 28	0 - 60
TIBC	261	250 – 350	250 - 450
UIBC	204	150 - 375	150 - 375
Iron	57	85 – 135	35 - 155
Iron saturation	22	15 – 45	15 - 55
Ferritin	697	MW: 30 - 150	15 - 150
Cholesterol, total	129	150 – 250	100 - 199
Triglycerides	96	50 – 100	0 - 149
HDL	49	55 – 85	> 39
LDL	61	0 – 175	0 - 99
T. Chol / HDL Ratio	2.6	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.96	< 2	< 3.8
TSH	<0.006	0.5 – 2.5	0.45 - 4.50
T4, total	8.2	6.0 – 12	4.5 - 12.0
T3 Uptake	25	28 - 35	24 - 39
T3, Total	154	100 – 180	71 - 180
Vitamin D, 25-hydroxy	29.8	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
WBC	10.0	5.0 – 8.0	3.4 - 10.8
RBC	5.75	4.4 – 4.9	3.77 - 5.28
Hemoglobin	15.7	13.5 - 14.5	11.1 - 15.9
Hematocrit	48	37 - 44	34.0 - 46.6
MCV	84	85 – 92	79 - 97
MCH	27.3	27.7 – 32.0	26.6 - 33.0
MCHC	32.7	32 – 35	31.5 - 35.7
RDW	14.9	11.5 – 15.0	12.3 - 15.4
Platelets	263	150 – 415	150 - 379
Neutrophils	73	40 – 60	
Lymphocytes	21	25 – 40	
Monocytes	5	4.0 – 7.0	
Eosinophils	1	0.0 – 3.0	
Basophils	0	0.0 – 3.0	
Additional Tests:			
T3, Free	3.6	2.5 - 4.0	2 - 4.4
T4, Free	1.14	1 - 1.5	0.82 - 1.77
CRP-hs	10.37	< 1.0	0.00 - 3.00
Copper	149		72 - 166
Zinc	95		56 - 134
Zinc / Copper Ratio	0.64	> 0.85	
Serum Methylmalonic Acid (MMA)	169	0 - 325	0 - 378
Homocysteine	7.3	< 9.0	0.0 - 15.0
Vitamin B-12	941	450 – 2000	211 - 946

This patient is a 66-year-old female with chief complaint of ulcerative colitis, depression, overweight, anxiety, and eczema. Note that her glucose and A1c are in the prediabetes range, and dehydration is potentially more of a risk factor for this reason. Her BUN is normal. Her sodium is high in the functional range. Her red blood cell and hematocrit are lab-high. Her hemoglobin is functionally high, and her potassium is normal.

This patient had chronic diarrhea, which was likely causing dehydration. She also drank two to three cups of coffee per day, did not drink water often, and did not eat a lot of high-water foods. Addressing diarrhea through gut protocols and increasing her fluid intake did normalize the dehydration markers in this case.

Let thirst be your guide…

Treatment of functional or chronic dehydration is not as involved as treatment of acute dehydration, and it mostly involves addressing the underlying causes and increasing fluid intake, but how much should each person drink given these individual factors? Thirst is a sufficient indicator for most people of their hydration status, and from an evolutionary perspective, thirst has done a pretty good job of enabling us to survive as a species. While many believe that thirst is an indicator that a person is already dehydrated, this claim has not been substantiated by any research. Thirst begins when the concentration of blood, an accurate indicator of our state of hydration, has risen by around 2 percent. Experts generally define dehydration as beginning when that concentration has risen by at least 5 percent. While thirst is a good indicator that a drink would help maintain good hydration, it doesn't necessarily imply that dehydration has set in.

...except in these situations.

Exceptions to thirst being a good guide for hydration might include athletes engaged in exceptionally strenuous activity, when dehydration is far more common, and adequate rehydration is essential to athletic performance as well as just general health. Drinking plain water can improve performance and endurance exercise, but there are further improvements when carbohydrate and electrolytes are added. Sodium should be included in fluids consumed during exercise lasting more than two hours, and it is beneficial for aiding rehydration for anyone engaged in moderate activity.

People with health conditions that affect their thirst, such as diabetes or kidney disease, may need more precise estimations of fluid needs on a daily basis. Excessive thirst is a symptom of hyperglycemia among other diseases and not necessarily an indication of dehydration. If the patient is constantly thirsty despite drinking regularly, you need to consider the possibility of diabetes insipidus or kidney disease.

As far as how to hydrate, pure water is probably good enough for recreational athletes engaged in mild-to-moderate activity. Those doing intense training or those who sweat excessively, however, will need electrolytes in addition to water and possibly even sodium tablets. Sodium is essential to avoid hyponatremia, a serious condition caused by a lack of salt in the blood, leading to water imbalance and water buildup in the brain. Therefore, sodium is one of the major electrolytes that is essential to include in a rehydration beverage that would be taken following strenuous exercise.

There are many great natural alternatives to commercial sports drinks for replacing electrolytes during and after exercise. Bone broth, for example, is full of minerals such as calcium and magnesium, which can help with muscle contraction and relaxation, as well as amino acids for improved muscle and joint repair, which makes it a good choice for athletes. Coconut water has a good mix of electrolytes and simple sugars to aid in sports performance, but extra salt may need to be added to some brands that are lower in sodium in order to optimize rehydration. Fermented pickle or sauerkraut juice is another great way to boost hydration, especially for those who need the extra sodium and electrolytes. Even just adding a pinch of sea salt to your water bottle should be sufficient to aid in rehydration after a trip to the gym. Finally, Katie the Wellness Mama has a great recipe for a homemade rehydration drink, and we'll put that link in the resources section.

The next pattern to talk about is changes in muscle mass. This is really basic, but you should at least be aware. On the case review blood panel, this is largely detected by creatinine. Let's start with decreased muscle mass. This can happen in cases of physical inactivity, aging, sarcopenia, fasting, malnutrition, IBD, and some chronic disease states such as diabetes, Cushing's syndrome, and renal or cardiac failure. Loss of muscle mass and strength primarily results from excessive protein breakdown, which is accompanied by reduced protein synthesis, and this leads to reduced quality of life and increased morbidity and mortality.

Markers to consider for decreased muscle mass

Marker	Level
Creatinine	Low
Total protein	Low
Albumin	Low
Albumin-to-globulin ratio	Low

These are the markers that may indicate decreased muscle mass and protein insufficiency: creatinine, total protein, albumin, and albumin-to-globulin ratio. They will most often be low in the functional range, though creatinine may be low in the lab range. If total protein, albumin, and

albumin-to-globulin ratio are below the lab range, you need to consider other more serious conditions such as kidney and liver disease.

Marker	Value	Functional Range	Lab Range
Glucose	124	75 – 90	65 - 99
Hemoglobin A1c	6.4	4.4 – 5.4	4.8 - 5.6
Uric Acid	6.0	3.2 - 5.5	2.5 - 7.1
BUN	15	13 – 18	8 - 27
Creatinine	0.56	0.85 – 1.1	0.57 - 1
Sodium	142	135 – 140	134 - 144
Potassium	4.3	4.0 – 4.5	3.5 - 5.2
Chloride	104	100 – 106	97 - 108
C02	20	25 – 30	18 - 29
Calcium	9.2	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.9	3.5 – 4.0	2.5 - 4.5
Magnesium	1.9	2.0 – 2.6	1.6 - 2.6
Protein, total	6.7	6.9 – 7.4	6.0 - 8.5
Albumin	4.5	4.0 – 5.0	3.6 - 4.8
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	0.5	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	118	42 – 107	39 - 117
LDH	178	140 - 180	119 - 226
AST	21	10 - 30	0 - 40
ALT	23	10 - 22	0 - 32
GGT	13	0 - 28	0 - 60
TIBC	261	250 – 350	250 - 450
UIBC	204	150 - 375	150 - 375
Iron	57	85 – 135	35 - 155
Iron saturation	22	15 – 45	15 - 55
Ferritin	697	MW: 30 - 150	15 - 150
Cholesterol, total	129	150 – 250	100 - 199
Triglycerides	96	50 – 100	0 - 149
HDL	49	55 – 85	> 39
LDL	61	0 – 175	0 - 99
T. Chol / HDL Ratio	2.6	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.96	< 2	< 3.8
TSH	<0.006	0.5 – 2.5	0.45 - 4.50
T4, total	8.2	6.0 – 12	4.5 - 12.0
T3 Uptake	25	28 - 35	24 - 39
T3, Total	154	100 – 180	71 - 180
Vitamin D, 25-hydroxy	29.8	35 - 60	30.0 - 100.0

Okay, we just saw this patient a few slides back in the dehydration section. She is a 66-year-old female with chief complaints of ulcerative colitis, depression, overweight, anxiety, and eczema. This is IBD causing malabsorption, leading to reduced muscle mass and low creatinine levels. She is also not exercising regularly because of her health conditions and depression. In her case, you'd have to address the IBD and mental health and then also getting her exercising and particularly lifting weights, which, of course, both of which would probably help her mental health, but it is a bit of a chicken and egg situation.

Muscle mass is really important to overall health, and decreased muscle mass is both a cause and an effect of chronic disease. In the elderly, it is associated with poor structural bone health and impaired balance, so it should be improved if it is low. Treatment of low muscle mass depends on the cause. If protein intake is too low, you need to obviously increase that. If it is due to malabsorption, you need to screen for celiac, non-celiac gluten sensitivity, or IBD. If it is simply due to physical inactivity, then you'd want to prescribe exercise and especially weightlifting. I think weightlifting is a good idea for all people who are aging and elderly, regardless of whether they have indicators of low muscle mass, because it has been shown to reduce the risk of age-related decline in bone health, falls, fractures, etc.

Markers to consider for increased muscle mass

Marker	Level
Creatinine	High
BUN	High

One thing you might often see if you treat patients on a Paleo diet and are doing CrossFit or intense exercise is mildly elevated creatinine and BUN. They may be functionally high or slightly out of the lab range. If other kidney markers are normal, and there are no signs and symptoms of kidney damage, the most likely explanation here is high protein intake and/or an increased muscle mass from lifting weights.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
Comp. Metabolic Panel (14)					
Glucose, Serum	92		mg/dL	65 - 99	01
BUN	16		mg/dL	6 - 24	01
Creatinine, Serum	**1.01**	**High**	mg/dL	0.57 - 1.00	01
eGFR If NonAfricn Am	68		mL/min/1.73	>59	
eGFR If Africn Am	79		mL/min/1.73	>59	
BUN/Creatinine Ratio	16			9 - 23	
Sodium, Serum	139		mmol/L	134 - 144	01
Potassium, Serum	4.6		mmol/L	3.5 - 5.2	01
Chloride, Serum	101		mmol/L	97 - 108	01
Carbon Dioxide, Total	23		mmol/L	18 - 28	01
Calcium, Serum	8.7		mg/dL	8.7 - 10.2	01
Protein, Total, Serum	6.1		g/dL	6.0 - 8.5	01
Albumin, Serum	4.3		g/dL	3.5 - 5.5	01
Globulin, Total	1.8		g/dL	1.5 - 4.5	
A/G Ratio	2.4			1.1 - 2.5	
Bilirubin, Total	0.5		mg/dL	0.0 - 1.2	01
Alkaline Phosphatase, S	49		IU/L	39 - 117	01
AST (SGOT)	25		IU/L	0 - 40	01
ALT (SGPT)	18		IU/L	0 - 32	01

Here is a good example of what this can look like in practice. Creatinine is only slightly elevated above the lab range. This is a 44-year-old female who does CrossFit three to four times a week. BUN and phosphorus, which isn't pictured here, and other kidney markers were normal, so this is nothing to be concerned about. It's simply a sign of higher-than-average muscle mass.

In most cases, a mild elevation of creatinine and BUN is due to increased muscle mass, and it doesn't require any treatment. There is, however, a condition called rhabdomyolysis, which involves a rapid breakdown of skeletal muscle tissue, which can be extremely serious and even fatal. It's rare, but it can happen in people who are exercising intensely, and there are cases of CrossFitters, for example, getting rhabdomyolysis, or rhabdo, as it's referred to in the bodybuilding community. It is an uncommon but documented side effect of statin drugs.

Rhabdomyolysis markers

Marker	Level
Creatine kinase (CK)	5x + higher than upper limit
LDH	High
ALT	High
AST	High
Potassium	High
Calcium	Low

In rhabdo, you may see elevated LDH, AST, ALT, and potassium as well as low serum calcium. The primary diagnostic marker is one I don't have in the case review panel, which is creatine kinase, and you'd expect to see levels of CK, or creatine kinase, five times above the normal upper limit of the lab range in rhabdomyolysis. Milder forms may not cause any muscle symptoms, and a diagnosis is based on abnormal blood tests in the context of other problems. More severe rhabdomyolysis is characterized by muscle pain, tenderness, weakness, and swelling of the affected muscles, and tea-colored urine, which is brownish, which is caused by the presence of myoglobin in the urine. If you see or suspect rhabdomyolysis in your patient, refer them to a nephrologist immediately. It is treatable, but it can cause irreversible kidney damage if it's not caught in time.

Okay, that's it for other metabolic patterns. See you next time.