

# Iron Overload - Part Five

In this section, we're going to look at case studies. We had to do a lot of background and didactic info for this particular marker, probably more than we'll do for any other marker in the blood chemistry unit, but I felt that was necessary, since the consequences of iron overload are so potentially serious, and yet it is so poorly understood in both the conventional and functional medicine settings, and it's so often underdiagnosed.

marker	value	Functional Range	Lab Range
Glucose	90	75 - 90	65 - 99
Hemoglobin A1c	5.5	4.4 - 5.4	4.8 - 5.6
Uric Acid	3.3	3.2 - 5.5	2.5 - 7.1
BUN	17	13 - 18	8 - 27
Creatinine	0.61	0.85 - 1.1	0.57 - 1
BUN/Creatinine Ratio	28	9 - 23	9 - 23
Sodium	141	135 - 140	134 - 144
Potassium	4.3	4.0 - 4.5	3.5 - 5.2
Chloride	99	100 - 106	97 - 108
CO2	29	25 - 30	18 - 29
Calcium	9.6	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.7	3.5 - 4.0	2.5 - 4.5
Magnesium	2.2	2.0 - 2.6	1.6 - 2.3
Protein, total	6.8	6.9 - 7.4	6.0 - 8.5
Albumin	4.3	4.0 - 5.0	3.5 - 4.8
Globulin	2.5	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.7	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.5	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	60	42 - 107	39 - 117
LDH	155	140 - 180	119 - 226
AST	18	10 - 30	0 - 40
ALT	14	10 - 22	0 - 32
GGT	15	< 15	0 - 60
TIBC	266	275 - 425	250 - 450
UIBC	133	175 - 350	150 - 375
Iron	133	40 - 135	35 - 155
Iron saturation	50	17 - 45	15 - 55
Ferritin	117	30 - 100	15 - 150
Vitamin B-12	948	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	41.9	35 - 60	30.0 - 100.0
Cholesterol, total	232	150 - 250	100 - 199
Triglycerides	92	50 - 100	0 - 149
HDL	69	55 - 85	> 39
LDL	145	0 - 175	0 - 99
T. Chol / HDL Ratio	3.4	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.33	< 2	< 3.8
CRP-hs	3.17	< 1.0	0.00 - 3.00
Homocysteine	9.8	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	3.120	0.5 – 2.5	0.45 - 4.50
T4, total	6.6	6.0 – 12	4.5 - 12.0
T3 Uptake	30	28 - 35	24 - 39
T3, Total	98	100 – 180	71 - 180
WBC	7.6	5.0 – 8.0	3.4 - 10.8
RBC	4.46	4.4 – 4.9	3.77 - 5.28
Hemoglobin	14.7	13.5 - 14.5	11.1 - 15.9
Hematocrit	45.2	37 - 44	34.0 - 45.6
MCV	101	85 – 92	79 - 97
MCH	33.0	27.7 – 32.0	26.6 - 33.0
MCHC	32.5	32 – 35	31.5 - 35.7
RDW	12.8	11.5 – 15.0	12.3 - 15.4
Platelets	211	150 – 415	150 - 379
Neutrophils	58	40 – 60	
Lymphocytes	33	25 – 40	
Monocytes	6	4.0 – 7.0	
Eosinophils	3	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

Here's the first patient, a 71-year-old female with chief complaints of GERD, indigestion, and constipation. She has Barrett's esophagus and was on PPIs. Note that she still has iron overload despite this. PPIs inhibit iron absorption. She also has weakness in the legs, fatigue, and joint pain, which are all potential symptoms of iron overload. If you look at her iron markers, you'll see they are in the reference range except UIBC, but several of them are out of the functional range. Her iron saturation is 50. Ferritin is 117, where it should be below 100 ideally in menopausal women. Note that her MCV is out of the lab range. Her hemoglobin, hematocrit, and MCH are functionally high. C-reactive protein is high, which is indicative of inflammation, not surprising given her symptoms and iron levels. As I mentioned in Part One, when you see elevated iron levels like this and inflammation, you typically want to retest. Her FeGGT score is 7. She had a baseline of 1, which was loss of libido before age 60, 2 for ferritin, 2 for GGT, and 2 for iron saturation, and this puts her in the moderate-risk category.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
<b>Fe+TIBC+Fer</b>					
<b>Iron Bind.Cap. (TIBC)</b>	<b>219</b>	<b>Low</b>	ug/dL	250 - 450	
<b>UIBC</b>	<b>97</b>	<b>Low</b>	ug/dL	150 - 375	01
Iron, Serum	122		ug/dL	35 - 155	01
<b>Iron Saturation</b>	<b>56</b>	<b>High</b>	%	15 - 55	
Ferritin, Serum	136		ng/mL	15 - 150	01

Here is the retest. Her iron saturation was higher at 56 percent. UIBC was lower, and remember that's an inverse marker, so it indicates worse iron overload. Her TIBC was also out of the lab range

this time. Her ferritin was not out of the lab range but was still out of the functional range. She also had severe SIBO, probably due to long-term PPI use. Ironically, both SIBO and PPIs are probably limiting the absorption of iron to some extent, which could be keeping this from getting even worse. So, treating the SIBO and gut issues, of course, is still a good idea, but you have to be careful and watch for an uptick in iron absorption, especially if you weren't doing anything to reduce iron overload, which, of course, you would do with this patient, and we'll talk more about that toward the end of the presentation.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
<b>Fe+TIBC+Fer</b>					
Iron Bind.Cap. (TIBC)	220	Low	ug/dL	250 - 450	
UIBC	118	Low	ug/dL	150 - 375	01
Iron, Serum	102		ug/dL	35 - 155	01
Iron Saturation	46		%	15 - 55	
Ferritin, Serum	129		ng/mL	15 - 150	01

Here's the iron panel after the first phlebotomy. Iron saturation dropped below 50. UIBC went up, but it's still out of range, as you can see, and ferritin didn't change much at all. Remember that ferritin is also an acute-phase reactant, which can be increased by inflammation. If a patient donates blood and ferritin doesn't budge, it may be inflammation that is keeping it high. That doesn't mean they don't have iron overload, which she clearly does, but it does mean you'll also have to address the inflammatory component.

Marker	Value	Functional Range	Lab Range
Glucose	101	75 - 90	65 - 99
Hemoglobin A1c	5.1	4.4 - 5.4	4.8 - 5.6
Uric Acid	6.4	3.7 - 6.0	3.7 - 8.6
BUN	14	13 - 18	6 - 24
Creatinine	1.06	0.85 - 1.1	0.76 - 1.27
BUN/Creatinine Ratio	13	8 - 19	9 - 20
Sodium	142	135 - 140	134 - 144
Potassium	4.6	4.0 - 4.5	3.5 - 5.2
Chloride	99	100 - 106	97 - 108
CO2	26	25 - 30	18 - 29
Calcium	9.4	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.1	3.5 - 4.0	2.5 - 4.5
Magnesium	2.3	2.0 - 2.6	1.6 - 2.3
Protein, total	6.7	6.9 - 7.4	6.0 - 8.5
Albumin	4.8	4.0 - 5.0	3.5 - 5.5
Globulin	1.9	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.5	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.7	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	67	42 - 107	39 - 117
LDH	154	140 - 180	121 - 224
AST	18	10 - 30	0 - 40
ALT	23	10 - 29	0 - 44
GGT	17	< 15	0 - 65
TIBC	251	275 - 425	250 - 450
UIBC	165	175 - 350	150 - 375
Iron	86	40 - 135	40 - 155
Iron saturation	34	17 - 45	15 - 55
Ferritin	1071	30 - 100	30 - 400
Vitamin B-12	695	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	27.3	35 - 60	30.0 - 100.0
Cholesterol total	202	150 - 240	100 - 199
Triglycerides	58	50 - 100	0 - 149
HDL	75	55 - 85	> 39
LDL	115	0 - 175	0 - 99
T. Chol / HDL Ratio	2.7	< 3	0 - 5.0
Triglycerides / HDL Ratio	0.77	< 2	< 3.8
CRP-hs	0.83	< 1.0	0.00 - 3.00
Homocysteine	12.0	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	1.440	0.5 – 2.5	0.45 - 4.50
T4, total	11.2	6.0 – 12	4.5 - 12
<b>T3 Uptake</b>	<b>25</b>	<b>30 - 38</b>	24 - 39
T3, Total	135	100 – 180	71 - 180
Copper	95		72 - 166
Zinc	94		56 - 134
Zinc / Copper Ratio	0.99	> 0.85	
Serum Methylmalonic Acid (MMA)	194	0 - 325	0 - 378
WBC	5.0	5.0 – 8.0	3.4 - 10.8
<b>RBC</b>	<b>5.45</b>	<b>4.4 – 4.9</b>	4.14 - 5.8
<b>Hemoglobin</b>	<b>16.8</b>	<b>14 - 15</b>	12.6 - 17.7
<b>Hematocrit</b>	<b>48.1</b>	<b>40 - 48</b>	37.5 - 51.0
MCV	88	85 – 92	79 - 97
MCH	30.8	27.7 – 32.0	26.6 - 33.0
MCHC	34.9	32 – 35	31.5 - 35.7
RDW	13.5	11.5 – 15.0	12.3 - 15.4
Platelets	178	150 – 415	150 - 379
<b>Neutrophils</b>	<b>69</b>	<b>40 – 60</b>	
<b>Lymphocytes</b>	<b>20</b>	<b>25 – 40</b>	
<b>Monocytes</b>	<b>10</b>	<b>4.0 – 7.0</b>	
Eosinophils	1	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

Here's another patient, a 56-year-old male with chief complaint of, in his words, "exceedingly frequent bouts of fatigue and illness and a sensitivity to a long list of foods." Now remember from Part One that fatigue is the number one symptom of iron overload. His ferritin is over 1,000. It's 1,071, and that's a level that is known to cause significant organ damage. It's very interesting to see that his other iron markers are completely normal. His UIBC, serum iron, and iron saturation aren't even out of the functional range. TIBC is just barely below the functional range, but if you were only looking at those other markers without ferritin, you would have no idea that he has severe iron overload. However, his red blood cells, hemoglobin, and hematocrit are high-normal, and his glucose is elevated. Ferritin is an acute-phase reactant, as I mentioned on the last slide, which can be elevated in the inflammatory response, so you might suspect looking at this profile that he doesn't have iron overload, and he only has inflammation. However, I have never seen ferritin this high when it's only due to inflammation and doesn't have at least a component of excess iron storage.

If you look at his FeGGT score, the baseline score is 2 for fatigue and elevated glucose. He gets 6 points for ferritin because it is so high, 2 for GGT, and total score is 9, putting him in the moderate-risk category.

23andMe Name	Other Name(s)	DNA Change	Genotype	Result
rs1800562	C282Y	G to A	AG	Has one mutation in the HFE gene linked to hemochromatosis. A person with one of these mutations is not typically prone to higher levels of iron in the body, but can pass the mutation to offspring. May have other mutations in the HFE gene (not reported here). Variants detected: C282Y
rs1799945	H63D	C to G	CC	
rs3002468	S65C	A to T	AA	

**Hemochromatosis (HFE-related) and Your Genes**

The human body needs iron for red blood cells, brain function, the immune system and healthy muscles. But if the amount of iron absorbed from food is not carefully controlled, the metal can build up in the tissues of major organs. Without treatment, iron overload can lead to organ damage and failure.

We went ahead and tested his gene status, and surprisingly, he was only a heterozygous carrier of C282Y. This really contradicts the idea that heterozygous carriers are not at risk for higher iron levels because clearly this person has very high ferritin levels and is not homozygous for any of the three main mutations and is not a compound heterozygote. Note that in the interpretation it says, clearly, that the patient may have other mutations in the HFE gene that aren't reported here, and we covered that in Part One. This test and most tests for genetic mutations that cause iron overload only screen for the three most common mutations. That means if you get a negative result, or you see even a positive for heterozygous carrier, like we see here, you can't rule out the possibility of other mutations that could be contributing to excess iron storage.

Patients with iron levels above 1,000 will need therapeutic phlebotomy to lower their blood levels. Blood banks won't take blood with this much iron in it because it can be harmful, and donating blood every 56 days, which is the maximum frequency if it is done in an outpatient setting such as Red Cross or a local hospital, is not going to be enough to lower ferritin levels sufficiently because it's probably accumulating too quickly. These patients will need a prescription for phlebotomy that is more frequent and is typically done up to one to two times a week until the patient reaches near-iron deficiency. That means lowering their ferritin to where it's at the border of deficiency, so maybe 30 for men.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
<b>Fe+TIBC+Fer</b>					
Iron Bind.Cap. (TIBC)	292		ug/dL	250 - 450	
UIBC	220		ug/dL	111 - 343	01
Iron, Serum	72		ug/dL	38 - 169	01
Iron Saturation	25		%	15 - 55	
<b>Ferritin, Serum</b>	<b>556</b>	<b>High</b>	ng/mL	30 - 400	01
<b>Hemoglobin</b>					
Hemoglobin	14.6		g/dL	12.6 - 17.7	01

What I'm showing you here on this slide is a result that is from about halfway through treatment. You can see that his ferritin has dropped to 556. All of his other iron markers are in the normal lab range, but UIBC is below the functional range. There is obviously still some iron overload here. Check out his hemoglobin. It's still perfectly adequate, so when you're doing therapeutic

phlebotomy, you have to watch the hemoglobin level because you don't want to induce anemia in the patient, but his hemoglobin of 14.6 is still perfectly adequate. It could keep going until this patient reaches near-iron deficiency.

Marker	Value	Functional Range	Lab Range
Glucose	87	75 - 90	65 - 99
Hemoglobin A1c	5.4	4.4 - 5.4	4.8 - 5.6
Uric Acid	4.8	3.7 - 6.0	3.7 - 8.6
BUN	15	13 - 18	6 - 24
Creatinine	1.00	0.85 - 1.1	0.76 - 1.27
BUN/Creatinine Ratio	15	8 - 19	8 - 19
Sodium	141	135 - 140	134 - 144
Potassium	4.2	4.0 - 4.5	3.5 - 5.2
Chloride	98	100 - 106	97 - 108
CO2	25	25 - 30	18 - 29
Calcium	9.5	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.4	3.5 - 4.0	2.5 - 4.5
Magnesium	2.0	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	0.8	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	81	42 - 107	39 - 117
LDH	157	140 - 180	121 - 224
AST	31	10 - 30	0 - 40
ALT	34	10 - 29	0 - 44
GGT	44	< 15	0 - 65
TIBC	371	275 - 425	250 - 450
UIBC	178	175 - 350	150 - 375
Iron	193	40 - 135	40 - 155
Iron saturation	52	17 - 45	15 - 55
Ferritin	234	30 - 100	30 - 400
Vitamin B-12	959	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	170.8	35 - 60	30.0 - 100.0
Cholesterol, total	185	150 - 240	100 - 199
Triglycerides	44	50 - 100	0 - 149
HDL	89	55 - 85	> 39
LDL	87	0 - 175	0 - 99
T. Chol / HDL Ratio	2.1	< 3	0 - 5.0
Triglycerides / HDL Ratio	0.49	< 2	< 3.8
CRP-hs	0.34	< 1.0	0.00 - 3.00
Homocysteine	8.2	< 7.0	0.0 - 15.0



Marker	Value	Functional Range	Lab Range
TSH	0.153	0.5 – 2.5	0.45 - 4.50
T4, total	9.2	6.0 – 12	4.5 - 12
T3 Uptake	36	30 - 38	24 - 39
T3, Total	96	100 – 180	71 - 180
WBC	6.8	5.0 – 8.0	3.4 - 10.8
RBC	4.92	4.4 – 4.9	4.14 - 5.8
Hemoglobin	16.0	14 - 15	12.6 - 17.7
Hematocrit	46.9	40 - 48	37.5 - 51.0
MCV	95	85 – 92	79 - 97
MCH	32.5	27.7 – 32.0	26.6 - 33.0
MCHC	34.1	32 – 35	31.5 - 35.7
RDW	13.6	11.5 – 15.0	12.3 - 15.4
Platelets	200	150 – 415	150 - 379
Neutrophils	47	40 – 60	
Lymphocytes	37	25 – 40	
Monocytes	14	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

Here's another case, a 47-year-old male with a history of irritable bowel syndrome, lower pelvic pain, and prostatitis. His serum iron is elevated out of the lab range at 193. Iron saturation and ferritin are above the functional range but still in the lab range. Note that his GGT is high-normal in the functional range, as is hemoglobin.

For his FeGGT risk score, he got 0 for baseline, 3 points for ferritin, 4 for iron saturation, 5 for GGT, 0 for hemoglobin. If he was above 17, he would have gotten 3, so he was close to that, for a total score of 12 points, which puts him in the high-risk category. Note that it is possible to get a high-risk score even with 0 baseline risk factors and with GGT, ferritin, and iron saturation in the normal laboratory reference range. It's very important to understand this, and that's why the FeGGT score is so important. Also note that his vitamin D level is 170, which is the highest level I'd ever seen. He was taking 10,000 IU for about two years, and this together with the high FeGGT puts him at a very high risk of cardiovascular disease. You'd want to do pretty aggressive treatment here to get his iron levels down and normalize his vitamin D levels as well.

Marker	Value	Functional Range	Lab Range
Glucose	111	75 - 90	65 - 99
Hemoglobin A1c	6.3	4.4 - 5.4	4.8 - 5.6
Uric Acid	5.2	3.2 - 5.5	2.5 - 7.1
BUN	21	13 - 18	6 - 24
Creatinine	0.63	0.85 - 1.1	0.57 - 1
BUN/Creatinine Ratio	33	9 - 23	9 - 23
Sodium	143	135 - 140	134 - 144
Potassium	4.3	4.0 - 4.5	3.5 - 5.2
Chloride	103	100 - 106	97 - 108
CO <sub>2</sub>	25	25 - 30	18 - 29
Calcium	9.2	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.4	3.5 - 4.0	2.5 - 4.5
Magnesium	2.0	2.0 - 2.6	1.6 - 2.6
Protein, total	7.0	6.9 - 7.4	6.0 - 8.5
Albumin	4.6	4.0 - 5.0	3.5 - 5.5
Globulin	2.4	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.9	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.3	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	106	42 - 107	39 - 117
LDH	133	140 - 180	119 - 214
AST	32	10 - 30	0 - 40
ALT	51	10 - 22	0 - 32
GGT	65	< 15	0 - 60
TIBC	373	275 - 425	250 - 450
UIBC	292	175 - 350	150 - 375
Iron	81	40 - 135	40 - 155
Iron saturation	22	17 - 45	15 - 55
Ferritin	49	30 - 100	15 - 150
Vitamin D, 25-hydroxy	27.5	35 - 60	30.0 - 100.0
Cholesterol, total	177	150 - 250	100 - 199
Triglycerides	161	50 - 100	0 - 149
HDL	43	55 - 85	> 39
LDL	102	0 - 175	0 - 99
T. Chol / HDL Ratio	4.1	< 3	0 - 4.4
Triglycerides / HDL Ratio	3.74	< 2	< 3.8
TSH	1.120	0.5 - 2.5	0.45 - 4.50
T <sub>4</sub> , total	8.8	6.0 - 12	4.5 - 12.0
T <sub>3</sub> Uptake	27	28 - 35	24 - 39
T <sub>3</sub> , Total	113	100 - 180	71 - 180
WBC	6.2	5.0 - 8.0	3.4 - 10.8
RBC	4.36	4.4 - 4.9	3.77 - 5.28
Hemoglobin	13.3	13.5 - 14.5	11.1 - 15.9

Here's an example of the flip side where all of the biomarkers for iron that are part of the FeGGT score are normal, even in the functional range. However, this woman had high baseline risks. She had a high fasting glucose, triglycerides, low HDL, prediabetes, hypertension, fatigue, loss of libido, and high waist circumference, so she had a baseline score of 8. Her blood markers score was 6, which was exclusively because of high GGT. She also scored in the high-risk category with a total score of 14, which demonstrates that it is possible to have a high FeGGT score even with normal iron markers, and in that case, it's more of an indicator of metabolic dysfunction than it is of iron overload.

Marker	Value	Functional Range	Lab Range
Glucose	88	75 - 90	65 - 99
Hemoglobin A1c	5.3	4.4 - 5.4	4.8 - 5.6
Uric Acid	4.8	3.7 - 6.0	3.7 - 8.6
<b>BUN</b>	<b>12</b>	<b>13 - 18</b>	6 - 20
Creatinine	1.07	0.85 - 1.1	0.76 - 1.27
BUN/Creatinine Ratio	11	8 - 19	8 - 19
<b>Sodium</b>	<b>142</b>	<b>135 - 140</b>	134 - 144
<b>Potassium</b>	<b>4.6</b>	<b>4.0 - 4.5</b>	3.5 - 5.2
Chloride	101	100 - 106	97 - 108
CO2	25	25 - 30	18 - 29
Calcium	9.9	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.7	3.5 - 4.0	2.5 - 4.5
Magnesium	2.2	2.0 - 2.6	1.6 - 2.3
Protein, total	6.9	6.9 - 7.4	6.0 - 8.5
Albumin	5.0	4.0 - 5.0	3.5 - 5.5
<b>Globulin</b>	<b>1.9</b>	<b>2.4 - 2.8</b>	1.5 - 4.5
<b>A/G ratio</b>	<b>2.6</b>	<b>1.5 - 2.0</b>	1.1 - 2.5
Bilirubin, total	0.5	0.1 - 1.2	0.0 - 1.2
<b>Alkaline Phosphatase</b>	<b>30</b>	<b>42 - 107</b>	39 - 117
<b>LDH</b>	<b>137</b>	<b>140 - 180</b>	121 - 224
AST	16	10 - 30	0 - 40
ALT	11	10 - 29	0 - 44
GGT	10	< 15	0 - 65
<b>TIBC</b>	<b>239</b>	<b>275 - 425</b>	250 - 450
<b>UIBC</b>	<b>94</b>	<b>175 - 350</b>	150 - 375
<b>Iron</b>	<b>145</b>	<b>40 - 135</b>	40 - 155
<b>Iron saturation</b>	<b>61</b>	<b>17 - 45</b>	15 - 55
Ferritin	361	30 - 100	30 - 400
Vitamin B-12	582	450 - 2000	211 - 946
<b>Vitamin D, 25-hydroxy</b>	<b>84.7</b>	<b>35 - 60</b>	30.0 - 100.0
Cholesterol, total	199	150 - 240	100 - 199
<b>Triglycerides</b>	<b>45</b>	<b>50 - 100</b>	0 - 149
HDL	78	55 - 85	> 39
<b>LDL</b>	<b>112</b>	<b>0 - 175</b>	<b>0 - 99</b>
T. Chol / HDL Ratio	2.6	< 3	0 - 5.0
Triglycerides / HDL Ratio	0.58	< 2	< 3.8
CRP-hs	0.1	< 1.0	0.00 - 3.00
<b>Homocysteine</b>	<b>13.8</b>	<b>&lt; 7.0</b>	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	1.650	0.5 – 2.5	0.45 - 4.50
T4, total	7.3	6.0 – 12	4.5 - 12
T3 Uptake	37	30 - 38	24 - 39
T3, Total	84	100 – 180	71 - 180
Copper	58		72 - 166
Zinc	136		56 - 134
Zinc / Copper Ratio	2.34	> 0.85	
Serum Methylmalonic Acid (MMA)	70	0 - 325	0 - 378
WBC	4.3	5.0 – 8.0	3.4 - 10.8
RBC	5.04	4.4 – 4.9	4.14 - 5.8
Hemoglobin	15.5	14 - 15	12.6 - 17.7
Hematocrit	45.3	40 - 48	37.5 - 51.0
MCV	90	85 – 92	79 - 97
MCH	30.8	27.7 – 32.0	26.6 - 33.0
MCHC	34.2	32 – 35	31.5 - 35.7
RDW	13.7	11.5 – 15.0	12.3 - 15.4
Platelets	212	150 – 415	150 - 379
Neutrophils	44	40 – 60	
Lymphocytes	44	25 – 40	
Monocytes	8	4.0 – 7.0	
Eosinophils	3	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

This is a 29-year-old male with GI issues, including bloating and constipation, and depression and anxiety symptoms for most of his life. As you can see, TIBC, UIBC, and iron saturation are all out of the lab range. Serum iron and ferritin are out of the functional range, although ferritin at 361 is almost out of the lab range. His FeGGT score had 0 for baseline, 4 for ferritin, 4 for iron saturation, 0 for GGT and hemoglobin for a total score of 8, putting him in the moderate-risk category. This just goes to show that, in this particular case, iron markers can contribute a significant amount to the FeGGT risk score, and lowering iron levels would put him into the normal-risk category.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL
<b>Fe+TIBC+Fer</b>				
Iron Bind.Cap. (TIBC)	234	Low	ug/dL	250 - 450
UIBC	121	Low	ug/dL	150 - 375
	**Effective January 18, 2016 the reference interval** for UIBC will be changing to:			
	Male			
			0 - 30 days	Not Estab.
			1 - 6 months	127 - 340
			7 months - 17 years	148 - 395
			>17 years	111 - 343
	Female			
			0 - 30 days	Not Estab.
			1 - 6 months	127 - 340
			7 months - 60 years	131 - 425
			>60 years	118 - 369
Iron, Serum	113		ug/dL	40 - 155
	**Effective January 18, 2016 the reference interval** for Iron, Serum will be changing to:			
	Male			
			0 - 30 days	35 - 160
			1 month - 1 year	18 - 126
			2 - 12 years	28 - 147
			13 - 17 years	26 - 169
			>17 years	38 - 169
	Female			
			0 - 30 days	27 - 133
			1 month - 1 year	18 - 126
			2 - 12 years	28 - 147
			13 - 17 years	26 - 169
			18 - 60 years	27 - 159
			>60 years	27 - 139
Iron Saturation	48		%	15 - 55
Ferritin, Serum	339		ng/mL	30 - 400

This is what his retest looked like. TIBC and UIBC were still low. Iron saturation and ferritin were still functionally high. Soluble transferrin receptor is normal in the lab range, but it's at the low end, and low-normal soluble transferrin receptor is suggestive of iron overload in the context of these other markers.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
Soluble Transferrin Receptor	13.4		nmol/L	12.2 - 27.3	02
Ceruloplasmin	12.8	Low	mg/dL	15.0 - 30.0	02
**Effective January 18, 2016 the reference interval** for Ceruloplasmin will be changing to:					
Male					
			0 - 30 days	Not Estab.	
			1 - 6 months	11.0 - 31.0	
			7 months - 12 years	18.0 - 35.0	
			>12 years	16.0 - 31.0	
Female					
			0 - 30 days	Not Estab.	
			1 - 6 months	11.0 - 31.0	
			>6 months	19.0 - 39.0	

  

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
<b>Copper, Urine</b>					
Copper, Urine	6		ug/L	Not Estab.	01
				Detection Limit = 1	
Creatinine(Crt),U	0.51		g/L	0.30 - 3.00	01
				Detection Limit = 0.10	
Copper/Crt Ratio	12		ug/g creat	0 - 49	
Copper,Urine 24 Hr	32		ug/24 hr	3 - 35	

I also tested his ceruloplasmin, because as you may have noted on the last slide, his serum copper levels were low, and his zinc was high. I suspected he may have Wilson's disease, which manifests with low or normal serum copper, low ceruloplasmin, and high urine copper and also low alkaline phosphatase, which he also had. His urine copper, as you can see, was high-normal at 32. The range was 3 to 35, and his ceruloplasmin was low at 12.8, so I referred him out for additional workup. It was discovered that his copper levels in his liver were high, and he did, in fact, have Wilson's disease. Interestingly enough, some studies have shown that Wilson's disease leads to iron accumulation in addition to copper accumulation, so that is probably what we're seeing here.