KRESSER INSTITUTE
FOR FUNCTIONAL AND EVOLUTIONARY MEDICINE

Impaired Kidney Function - Part Two

All right, let's look at a few cases.

Marker	Value	Functional Range	Lab Range
Glucose	84	75 – 90	65 - 99
Hemoglobin A1c	5.5	4.4 – 5.4	4.8 - 5.6
Uric Acid	6.1	3.2 - 5.5	2.5 - 7.1
BUN	28	13 – 18	6 - 24
Creatinine	0.88	0.85 – 1.1	0.57 - 1
Sodium	141	135 – 140	134 - 144
Potassium	4.3	4.0 – 4.5	3.5 - 5.2
Chloride	102	100 – 106	97 - 108
C02	23	25 – 30	18 - 29
Calcium	9.6	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.5	3.5 – 4.0	2.5 - 4.5
Magnesium	2.1	2.0 – 2.6	1.6 - 2.6
Protein, total	6.5	6.9 – 7.4	6.0 - 8.5
Albumin	4.7	4.0 – 5.0	3.5 - 5.5
Globulin	1.8	2.4 – 2.8	1.5 - 4.5
A/G ratio	2.6	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.2	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	52	42 – 107	39 - 117
LDH	168	140 - 180	119 - 226
AST	13	10 - 30	0 - 40
ALT	9	10 - 22	0 - 32
GGT	9	0 - 28	0 - 60
TIBC	308	250 – 350	250 - 450
UIBC	246	150 - 375	150 - 375
Iron	62	85 – 135	35 - 155
Iron saturation	20	15 – 45	15 - 55
Ferritin	118	MW: 30 - 150	15 - 150
Cholesterol, total	227	150 – 250	100 - 199
Triglycerides	58	50 – 100	0 - 149
HDL	77	55 – 85	> 39
LDL	138	0 – 175	0 - 99
T. Chol / HDL Ratio	2.9	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.75	< 2	< 3.8
TSH	1.630	0.5 – 2.5	0.45 - 4.50
T4, total	7.9	6.0 – 12	4.5 - 12.0
T3 Uptake	28	28 - 35	24 - 39
T3, Total	82	100 – 180	71 - 180
Vitamin D, 25-hydroxy	35.4	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
WBC	6.8	5.0 – 8.0	3.4 - 10.8
RBC	4.36	4.4 – 4.9	3.77 - 5.28
Hemoglobin	12.4	13.5 - 14.5	11.1 - 15.9
Hematocrit	37.5	37 - 44	34.0 - 46.6
MCV	86	85 – 92	79 - 97
MCH	28.4	27.7 – 32.0	26.6 - 33.0
MCHC	33.1	32 – 35	31.5 - 35.7
RDW	14.0	11.5 – 15.0	12.3 - 15.4
Platelets	271	150 – 415	150 - 379
Neutrophils	54	40 – 60	
Lymphocytes	37	25 – 40	
Monocytes	7	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	0	0.0 – 3.0	
Additional Tests:			
CRP-hs	0.63	< 1.0	0.00 - 3.00
Homocysteine	9.7	< 9.0	0.0 - 15.0
Vitamin B-12	616	450 – 2000	211 - 946
Copper	139		72 - 166
Zinc	80		56 - 134
Zinc / Copper Ratio	0.58	> 0.85	
Serum Methylmalonic Acid (MMA)	171	0 - 325	0 - 378

This is a 50-year-old female with chief complaint of fatigue, joint pain, muscle pain, nerve pain in the pelvis and hips, stiff jaw, frequent urination, and stomach pain. The only kidney function marker that is elevated here is BUN. Sodium is one point above the functional range, but again, this is one of the ranges that was based on narrowing the lab reference range by 20 or 30 percent. It's definitely not specific evidence of kidney disease, and I wouldn't be concerned in this case.

When only BUN is elevated, and there aren't any other markers of kidney dysfunction, the two most likely causes are dehydration or high protein intake. With dehydration, RBC and/or hemoglobin will often be slightly above the upper limit of the functional range but not out of the lab range, and this is more common in men than it is in women, but it can happen in women too. As you can see here, that's not the case with this particular patient because her RBC and hemoglobin are actually a little bit low, bordering on the functional anemia range.

BUN stands for blood, urea, and nitrogen. Urea is made when protein is broken down by your body, so if the patient is on a high-protein Paleo-type diet, you can see a nonpathological increase in BUN just due to that high-protein intake, and that is likely what is happening here.

Marker	Value	Functional Range	Lab Range
Glucose	96	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	30	13 – 18	6 - 24
Creatinine	0.75	0.85 – 1.1	0.57 - 1
Sodium	139	135 – 140	134 - 144
Potassium	4.2	4.0 – 4.5	3.5 - 5.2
Chloride	98	100 – 106	97 - 108
C02	28	25 – 30	18 - 29
Calcium	10.0	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.5	3.5 – 4.0	2.5 - 4.5
Magnesium	2.1	2.0 – 2.6	1.6 - 2.6
Protein, total	7.1	6.9 – 7.4	6.0 - 8.5
Albumin	4.8	4.0 – 5.0	3.5 - 5.5
Globulin	2.3	2.4 – 2.8	1.5 - 4.5
A/G ratio	2.1	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.4	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	84	42 – 107	39 - 117
LDH	170	140 - 180	119 - 226
AST	85	10 - 30	0 - 40
ALT	123	10 - 22	0 - 32
GGT	19	0 - 28	0 - 60
TIBC	318	250 – 350	250 - 450
UIBC	226	150 - 375	150 - 375
Iron	92	85 – 135	35 - 155
Iron saturation	29	15 – 45	15 - 55
Ferritin	95	MW: 30 - 150	15 - 150
Cholesterol, total	144	150 – 250	100 - 199
Triglycerides	52	50 – 100	0 - 149
HDL	71	55 – 85	> 39
LDL	63	0 – 175	0 - 99
T. Chol / HDL Ratio	2.0	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.73	< 2	< 3.8
TSH	0.126	0.5 – 2.5	0.450 - 4.500
T4, total	3.7	6.0 – 12	4.5 - 12.0
T3 Uptake	28	28 - 35	24 - 39
T3, Total	84	100 – 180	71 - 180
Vitamin D, 25-hydroxy	42.6	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
WBC	4.8	5.0 – 8.0	3.4 - 10.8
RBC	4.35	4.4 – 4.9	3.77 - 5.28
Hemoglobin	14.0	13.5 - 14.5	11.1 - 15.9
Hematocrit	43.6	37 - 44	34.0 - 46.6
MCV	100	85 – 92	79 - 97
MCH	32.2	27.7 – 32.0	26.6 - 33.0
MCHC	32.1	32 – 35	31.5 - 35.7
RDW	13.2	11.5 – 15.0	12.3 - 15.4
Platelets	248	150 – 415	150 - 379
Neutrophils	49	40 – 60	
Lymphocytes	36	25 – 40	
Monocytes	12	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	1	0.0 – 3.0	
Additional Tests:			
CRP-hs	1.16	< 1.0	0.00 - 3.00
Homocysteine	7.1	< 9.0	0.0 - 15.0
Vitamin B-12	>1999	450 – 2000	211 - 946
Copper	134		72 - 166
Zinc	114		56 - 134
Zinc / Copper Ratio	0.85	> 0.85	
Serum Methylmalonic Acid (MMA)	123	0 - 325	0 - 378

The next patient is a 50-year-old female with the primary complaint of losing muscle mass and strength and bowel irregularity. As you can see, her creatinine is normal, as is her eGFR, which is not pictured here. Her phosphorus and potassium are also normal, but her BUN is significantly elevated at 30, as are her AST and ALT.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL
CMP14+LP+TP+TSH+5AC+CBC/D/P...				
Glucose, Serum	96		mg/dL	65 - 99
Hemoglobin A1c	5.2		%	4.8 - 5.6
Increased risk for diabetes: 5.7 - 6.4 Diabetes: >6.4 Glycemic control for adults with diabetes: <7.0				
Uric Acid, Serum	4.5		mg/dL	2.5 - 7.1
Please Note: Therapeutic target for gout patients: <6.0				
BUN	**30**	**High**	mg/dL	6 - 24
Creatinine, Serum	0.75		mg/dL	0.57 - 1.00
eGFR If NonAfricn Am	91		mL/min/1.73	>59
eGFR If Africn Am	105		mL/min/1.73	>59
BUN/Creatinine Ratio	**40**	**High**		9 - 23
Sodium, Serum	139		mmol/L	134 - 144
Potassium, Serum	4.2		mmol/L	3.5 - 5.2
Chloride, Serum	98		mmol/L	97 - 108
Carbon Dioxide, Total	28		mmol/L	18 - 29
Calcium, Serum	10.0		mg/dL	8.7 - 10.2
Phosphorus, Serum	3.5		mg/dL	2.5 - 4.5
Magnesium, Serum	2.1		mg/dL	1.6 - 2.6
Protein, Total, Serum	7.1		g/dL	6.0 - 8.5
Albumin, Serum	4.8		g/dL	3.5 - 5.5
Globulin, Total	2.3		g/dL	1.5 - 4.5
A/G Ratio	2.1			1.1 - 2.5
Bilirubin, Total	0.4		mg/dL	0.0 - 1.2
Alkaline Phosphatase, S	84		IU/L	39 - 117
LDH	170		IU/L	119 - 226
AST (SGOT)	**85**	**High**	IU/L	0 - 40
ALT (SGPT)	**123**	**High**	IU/L	0 - 32
GGT	19		IU/L	0 - 60
Iron Bind.Cap.(TIBC)	318		ug/dL	250 - 450
UIBC	226		ug/dL	150 - 375
Iron, Serum	92		ug/dL	35 - 155

Because her BUN is quite high and creatinine is low, her BUN-to-creatinine ratio is very high at 40. Potential causes of a high BUN-to-creatinine ratio include heart failure, liver cirrhosis, very-high-protein diet, and upper GI bleeding. In fact, one study in children found that a BUN-to-creatinine ratio above 30 had a sensitivity of 69 percent and a specificity of 98 percent for upper GI bleeding and steroid use. This patient was a vegetarian for 25 years, so high protein intake is very unlikely to be the cause of her elevated BUN-to-creatinine ratio. Also, her AST and ALT were quite high, as you can see, well out of the lab range in both cases, 85 for AST and 123 for ALT. When the BUN-to-creatinine ratio is over 20, the problem is often prerenal, meaning before the kidney. BUN reabsorption is increased, leading to high BUN relative to creatinine. Dehydration or hypoperfusion from hypovolemia, vomiting, diarrhea, diuretic use, hypotension, infection, and use of NSAIDs and ACE inhibitors are the most common causes in this case. What I would do here is retest all of these markers and do a fecal occult blood test, and then I would consider referring out to a nephrologist, depending on the results.

Marker	Value	Functional Range	Lab Range
Glucose	79	75 – 85	65 – 99
Hemoglobin Alc	5.4	4.4 – 5.4	4.8 – 5.6
Uric Acid	5.4	M: 3.7 – 6.0	3.7 - 8.6
BUN	19	13 – 18	6 – 24
Creatinine	1.38	0.85 – 1.1	0.76 - 1.27
Sodium	139	135 – 140	134 – 144
Potassium	4.6	4.0 – 4.5	3.5 – 5.2
Chloride	99	100 – 106	97 – 108
C02	26	25 – 30	18 - 29
Calcium	9.0	9.2 – 10.1	8.7 – 10.2
Phosphorus	3.6	3.5 – 4.0	2.5 – 4.5
Magnesium	2.2	2.0 – 2.5	1.6 – 2.6
Protein, total	6.6	6.9 – 7.4	6.0 – 8.5
Albumin	4.0	4.0 – 5.0	3.5 – 5.5
Globulin	2.6	2.4 – 2.8	1.5 – 4.5
A/G ratio	1.5	1.5 – 2.0	1.1 – 2.5
Bilirubin, total	0.7	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	36	42 – 107	39 - 117
LDH	175	140 - 180	0 – 225
AST	26	10 - 26	0 – 40
ALT	38	10 – 26	0 – 44
GGT	18	10 -26	0 -65
TIBC	349	250 – 350	250 – 450
UIBC	230	150 - 375	150 – 375
Iron	119	85 – 135	40– 155
Iron saturation	34	15 – 40	15 – 55
Ferritin	49	M: 33-100	30 - 400
Cholesterol, total	264	150 – 250	100 – 199
Triglycerides	65	50 – 100	0 – 149
HDL	56	55 – 85	› 39
LDL	195	0 – 175	0 – 99
Triglycerides / HDL Ratio	1.160	‹ 2	‹ 3.8
TSH	1.670	0.5 – 2.5	0.450 – 4.50
T4, total	7.0	6.0 – 12	4.5 – 12.0
T3 Uptake	29	M: 30-38	24 – 39
T3, Total	117	100 – 180	71 – 180
Vitamin D, 25-hydroxy	29.9	35 - 60	30.0 - 100.0
WBC	5.2	5.0 – 8.0	3.4 - 10.8
RBC	5.10	4.4 – 4.9	4.14 - 5.80
Hemoglobin	15.2	M: 14-15	12.6 - 17.7

This patient is a 46-year-old male with no health concerns other than cholesterol and heart disease risk. He had a high total cholesterol and a strong family history of heart disease and wanted to do what he could to avoid it. As you can see, creatinine is high, although his eGFR is normal. Potassium, BUN, and ALT are all slightly above the functional range. When you see elevated creatinine but other markers are relatively normal, one possible cause, especially in people who are fitness oriented, is increased muscle mass. Studies have shown that creatinine correlates with both lean mass and dietary protein intake. This patient was on a Paleo diet, lifted weights regularly, and was very muscular. You'll see a lot of isolated elevations of BUN or creatinine for this reason, so make sure to ask the patient about their diet and their muscle mass to clarify results. If both BUN

and creatinine are elevated, it's more likely they have kidney disease, especially if they have symptoms, are at risk, and have other markers of kidney dysfunction.

	Value	Functional Range	Lab Range
Hematocrit	46.2	M: 40-48	37.5 - 51.0
MCV	91	85 – 92	79 - 97
MCH	29.8	27.7 – 32.0	26.6 - 33.0
MCHC	32.9	32 – 35	31.5 - 35.7
RDW	13.2	11.5 – 15.0	12.3 - 15.4
Platelets	185	150 – 415	150 - 379
Neutrophils	60	40 – 60	40 -74
Lymphocytes	34	25 – 40	14 – 46
Monocytes	5	4.0 – 7.0	4 - 12
Eosinophils	1	0.0 – 3.0	0 - 5
Basophils	0	0.0 – 3.0	0 - 3
B-12	422	450 – 2000	211 - 946
Additional Tests:			
C- Reactive Protein	0.58		0.00 – 3.00
Homocysteine	13.8		0.00 – 15.0
Sed Rate (Westergren)	2		0 – 15

Cystatin C 0.78 mg/L 0.53 - 0.95

To be safe in this case, because of the high ALT level and his family history, we tested cystatin C, which you can see on the right at the very bottom, and it was normal.

Marker	Value	Functional Range	Lab Range
Glucose	77	75 – 85	65 – 99
Hemoglobin Alc	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

The next patient is a 43-year-old male with chief complaint of being overweight, fatigue, poor exercise tolerance, and heart disease risk. He owned a construction company. He sat in front of a computer most of the day, worked insane hours, was under a lot of stress, didn't make any time for physical activity, and was not eating well. His creatinine is high. His eGFR was normal. Phosphorus is low rather than high. BUN is slightly above the functional range.

He had several markers of metabolic dysfunction, as you can see in his lab work. His hemoglobin A1c is slightly high at 5.5, although his fasting glucose was normal at 77. Ferritin was very high at 534. Triglycerides were borderline high at 148. Vitamin D was low. AST, ALT, GGT, and LDH are all outside of the functional range, and then his LDL-P was extremely high at 2,900. Small LDL-P, which is in many ways a marker of metabolic function, was also very high at 1,124, and his lipoprotein(a) was high at 277. His lipoprotein insulin resistance, or LPIR, score was high at 70. His blood pressure was 140 to 150/90, so there are some clear signs of a problem here. He has two of the main risk factors for chronic kidney disease, with high blood pressure, metabolic dysfunction, and cardiovascular risk. In this case, since his eGFR is normal, he is unlikely to have chronic kidney disease, but he is probably headed in that direction if he doesn't get the metabolic dysfunction under control.

Metabolic	25-hydroxy-Vitamin D (ng/mL)†			24		≤ 14	15 - 29	30 - 100
	Uric Acid (mg/dL)†				4.8	≥ 8.0	7.0 – 7.9	2.0 – 6.9
	TSH (µIU/mL)		6.87			< 0.27 or > 4.20		0.27 - 4.20
	Homocysteine (µmol/L)		16			> 13	11 - 13	< 11
	Vitamin B_{12} (pg/mL)†				1356	< 211	211 - 400	> 400
	RBC Folate (ng/mL)				> 1429	< 700	700 - 750	> 750
	CoQ10 (µg/mL)§				2.99	< 1.11	1.11 – 2.00	> 2.00 Target of therapy for patients on statins is > 2.0 µg/mL.

TSH is analyzed using reagents from Roche Diagnostics by electrochemiluminescence immunoassay. These values should not be used in conjunction with values from other reagent manufacturers or methodologies.

Metabolic	Cortisol (µg/dL)		0.9			Morning hours 7-10 a.m.: 6.2-19.4 Afternoon hours 4-8 p.m.: 2.3-11.9 Other or unknown collection time: 2.3-19.4		
Renal	Cystatin C (mg/L)		1.19			≥ 1.04	0.96 - 1.03	≤ 0.95
	Estimated Glomerular Filtration Rate (eGFR, mL/min/1.73m2)			63		< 60	60 - 89	> 89
	Microalbumin (urine) (mg albumin/g of creatinine)				11	≥ 30		≤ 29
	Creatinine, serum (mg/dL)				0.8	> 0.9		0.5 - 0.9

Okay, the next patient is a 66-year-old woman with chief complaint of muscle pain all over her body. During the case review, we used the True Health Diagnostics* test because her insurance would cover it, and our panel has cystatin C, which was high for her, as you can see. eGFR was also borderline low.

* **Note:** True Health Diagnostics is no longer in business. See **this post** for the latest updates.

Glycemic Control	Glucose (mg/dL)			59		> 125	100-125	70 - 99
	HbA1c (%)			5.8		≥ 6.5	5.7 - 6.4	≤ 5.6
	Estimated Average Glucose (mg/dL) (calculated)			119.8		≥ 139.9	116.9 - 139.8	≤ 116.8
	Fructosamine (µmol/L)				230	> 346	302 - 346	< 302
	Glycation Gap				0.31	> 0.77	0.45 - 0.77	< 0.45
	Postprandial Glucose Index		21.5			> 7.9	6.0 - 7.9	< 6.0
Insulin Resistance	Leptin (ng/mL)			35		> 43	20 - 43	< 20
	Leptin:BMI Ratio		1.39			> 1.17	0.66 - 1.17	< 0.66
	Adiponectin (µg/mL)			14		< 10	10 - 14	> 14
	Free Fatty Acid (mmol/L)		0.73			> 0.70	0.60 - 0.70	< 0.60
	Ferritin (ng/mL) *		141			> 108	61 - 108	< 61
	α-hydroxybutyrate (µg/mL)§				3.5	> 5.7	4.5 - 5.7	< 4.5
	Oleic Acid (µg/mL)§		81			> 79	60 - 79	< 60
	Linoleoyl-GPC (µg/mL)§				16.1	< 10.5	10.5 - 13.0	> 13.0
	IR_i Score (calculated)				11.0	< 8.0	8.0 - 10.0	> 10.0
	HOMA-IR (calculated)				1.1	> 4.2	2.6 - 4.2	< 2.6
Beta Cell Function	Insulin (µU/mL)				8	≥ 12	10 - 11	3 - 9
	Proinsulin (pmol/L)			11		> 16	8 - 16	< 8
	C-peptide (ng/mL)			3.1		> 4.6	3.1 - 4.6	1.0 - 3.0
	Proinsulin:C-peptide Ratio			3.7		> 4.9	3.6 - 4.9	< 3.6
	Anti-GAD (IU/mL)				< 5	> 5 Positive		≤ 5 Negative

She also had some markers suggestive of dysglycemia: low fasting glucose, high A1c, borderline high leptin, adiponectin, proinsulin, and C-peptide; high ferritin; oleic acid; free fatty acids; and leptin-to-BMI ratio.

URINALYSIS, COMPLETE W/REFLEX TO CULTURE 08/07/2015 (#703269, Final, 08/06/2015)

Report	Result	Ref. Range	Units		Status	Lab
COLOR	YELLOW	YELLOW		Normal	Final	EN
APPEARANCE	CLEAR	CLEAR		Normal	Final	EN
SPECIFIC GRAVITY	1.012	1.001-1.035		Normal	Final	EN
PH	6.5	5.0-8.0		Normal	Final	EN
GLUCOSE	NEGATIVE	NEGATIVE		Normal	Final	EN
BILIRUBIN	NEGATIVE	NEGATIVE		Normal	Final	EN
KETONES	NEGATIVE	NEGATIVE		Normal	Final	EN
OCCULT BLOOD	**TRACE**	**NEGATIVE**		**Abnormal**	**Final**	**EN**
PROTEIN	NEGATIVE	NEGATIVE		Normal	Final	EN
NITRITE	NEGATIVE	NEGATIVE		Normal	Final	EN
LEUKOCYTE ESTERASE	NEGATIVE	NEGATIVE		Normal	Final	EN
WBC	NONE SEEN	< OR = 5	/HPF	Normal	Final	EN
RBC	NONE SEEN	< OR = 2	/HPF	Normal	Final	EN
SQUAMOUS EPITHELIAL CELLS	NONE SEEN	< OR = 5	/HPF	Normal	Final	EN
BACTERIA	NONE SEEN	NONE SEEN	/HPF	Normal	Final	EN
HYALINE CAST	NONE SEEN	NONE SEEN	/LPF	Normal	Final	EN
COPY(IES) SENT TO:					Final	
	COPY TO-NEPHROLOGY SPECIALIST **COPY TO ACCT FOR HOAG HIE*** 520 SUPERIOR AVE STE 340 NEWPORT BEACH, CA 92663-3674					
NOTE FROM LAB	FASTING:NO					

INTERPRETATION:

1. Bilateral polycystic renal disease. The largest cyst measures 12.9 cm in the left kidney.
2. Multiple liver cysts identified the largest measuring 7.7 cm.

COMMENT: Real-time ultrasound imaging of the abdomen was performed with transverse and longitudinal imaging.

There are no gallstones identified. The gallbladder wall is not thickened. The common bile duct is not dilated. It measures 0.4 cm in diameter. The liver is not enlarged. It measures 18.7 cm in length. There are multiple cysts of varying sizes in the liver. The largest cyst in the right lobe measures 7.7 cm. In the left lobe there is a 4 cm cyst.
The pancreas appears within normal limits. The spleen is homogeneous in echogenicity. It is not enlarged.
The right kidney measures 22.1 cm in length. There are multiple simple cysts in the right kidney of varying sizes. The largest cyst measures 10.9 cm. The left kidney measures 21.8 cm in length. There are multiple cysts in the left kidney of varying sizes. The largest cyst measures 12.9 cm. There is no hydronephrosis or solid renal mass seen. There is no ascites seen. There is no evidence for abdominal aortic aneurysm. The inferior vena cava appears normal.

Given the sensitivity and specificity of cystatin C, I referred her out for urinalysis and ultrasound. Urinalysis, as you can see, found occult blood but not protein in the urine. Ultrasound revealed bilateral polycystic renal disease and multiple liver cysts. Further workup revealed that she had a genetic condition leading to polycystic liver and kidney disease.

RENAL FUNCTION PANEL 08/07/2015 (#703268, Final, 08/06/2015)

Report	Result	Ref. Range	Units		Status	Lab
GLUCOSE	89	65-99	mg/dL	Normal	Final	EN
	Fasting reference interval					
UREA NITROGEN (BUN)	19	7-25	mg/dL	Normal	Final	EN
CREATININE	0.72	0.50-0.99	mg/dL	Normal	Final	EN
	For patients >49 years of age, the reference limit for Creatinine is approximately 13% higher for people identified as African-American.					
EGFR NON-AFR. AMERICAN	87	> OR = 60	mL/min/1.73m2	Normal	Final	EN
EGFR AFRICAN AMERICAN	101	> OR = 60	mL/min/1.73m2	Normal	Final	EN
BUN/CREATININE RATIO	NOT APPLICABLE	6-22	(calc)		Final	EN
SODIUM	137	135-146	mmol/L	Normal	Final	EN
POTASSIUM	4.0	3.5-5.3	mmol/L	Normal	Final	EN
CHLORIDE	106	98-110	mmol/L	Normal	Final	EN
CARBON DIOXIDE	21	19-30	mmol/L	Normal	Final	EN
CALCIUM	8.9	8.6-10.4	mg/dL	Normal	Final	EN
PHOSPHATE (AS PHOSPHORUS)	**4.6**	**2.1-4.3**	**mg/dL**	**High**	**Final**	**EN**
ALBUMIN	4.1	3.6-5.1	g/dL	Normal	Final	EN
COPY(IES) SENT TO:					Final	
	COPY TO-NEPHROLOGY SPECIALIST **COPY TO ACCT FOR HOAG HIE*** 520 SUPERIOR AVE STE 340 NEWPORT BEACH, CA 92663-3674					
NOTE FROM LAB	FASTING:NO					

Note that her eGFR was normal on previous lab work, as were creatinine, sodium, and potassium, and phosphorus was really the only kidney marker that was high, so we were lucky to catch this on her case review blood work.

Functional treatment of impaired kidney function almost exclusively involves addressing underlying causes. There are some botanicals that have been shown to benefit kidney function, but you need to be careful because people with kidney disease have a decreased ability to excrete byproducts and waste products, and some botanicals contain substances that people with kidney disease need to limit.

Botanicals high in **potassium**	Botanicals high in **phosphorus**
Alfalfa	American Ginseng
Bitter Melon (fruit, leaf)	Buch (leaf)
Chervil (leaf)	Feverfew
Coriander (leaf)	Indian Sorrel (seed)
Evening Primrose	Pokeweed (shoot)
Genipap (fruit)	Silk Cotton Tree (seed)
Kelp	Turmeric (rhizome)
Mugwort	Bitter Melon
Purslane Sage (leaf)	Coriander (leaf)
Scullcap	Flaxseed (seed)
Turmeric (rhizome)	Milk Thistle
American Ginseng	Purslane
Black Mustard (leaf)	Stinging Nettle (leaf)
Chicory (leaf)	Water Lotus
Dandelion (root, leaf)	Borage (leaf)
Feverfew	Evening Primrose
Goto Kola	Horseradish (root)
Kudzu (shoot)	Onion (leaf)
Noni	Shepherd's Purse
Safflower (flower)	Sunflower (seed)
Shepherd's Purse	Yellow Dock
Water Lotus	
Bai Zhi (root)	
Blessed Thistle	
Chinese Boxthorn (leaf)	
Dulse	
Garlic (leaf)	
Japanese Honeysuckle (flower)	
Lemongrass	
Papaya (leaf, fruit)	
Sassafras	
Stinging Nettle (leaf)	

Botanicals and **nutrients of additional concern**
Astragalus
Apium Graveolens
Horsetail
Licorice Root
Parsley Root
Uva Ursi
Barberry
Creative
Huperzinea
Nettle, Stinging Nettle
Pennyroyal
Yohimbe
Cat's Claw
Goldenrod
Java Tea Leaf
Oregon Grape Root
Ruta Graveolens

I've made a list here of botanicals that are high in potassium and phosphorus and botanicals and nutrients that are of additional concern for people with kidney disease. As you'll see, the lists are very long, and there are many commonly used botanicals such as turmeric, ginseng, dandelion, parsley root, uva ursi, nettle, etc. Now, different clinicians will vary in their use of these botanicals in situations where people have chronic kidney disease, and it's true that some of these may be useful in certain situations, but you should know what you're doing with these before you use them because they are documented as being potentially problematic, and if a problem were to occur, you could be liable in that situation.

That said, there are some things you can do to promote kidney health overall, especially protecting against kidney stones. The first is to balance fat-soluble vitamin intake. We require more than just vitamin D, of course, to properly metabolize calcium in our diets in our blood, and yet, unfortunately, most nephrologists and dietitians never consider the role that other fat soluble vitamins play in calcium metabolism. Vitamins A and K2 are two nutrients that are crucial for balancing out the effects of vitamin D in making sure that the calcium from our diet gets deposited in our bones and not in our arteries. Adequate vitamin A intake protects against excess vitamin D, and there is some evidence that vitamin K2 may have a protective effect as well.

Furthermore, vitamin K2 may play an independent role in kidney stone development. Patients with kidney stones secrete vitamin K2-dependent protein in its inactive form, which is between four and 20 times less effective than its active form at inhibiting the growth of calcium oxalate crystals, suggesting that vitamin K2 deficiency could be a major cause of kidney stones.

The next step is to ensure adequate magnesium intake. You know from the magnesium presentation now that many people are deficient, and it's often underdiagnosed. Studies show that magnesium can lower the risk of stone formation when taken as a supplement.

Third, there is some evidence that people with hypertension may have impaired sodium transport in the kidney, leading to salt sensitivity. Studies suggest a causal role of genetic, nutritional, metabolic, and neurohormonal factors. All of these factors alone or in combination may be able to impair the normal renal tubular sodium handling and influence blood pressure homeostasis.

Obesity itself also seems to impair the renal handling of sodium. One study showed the blood pressure of obese and lean adolescents was similar on a low-salt diet, but after switching to a high-salt intake, the obese group had a much greater increase in blood pressure. If you have a patient with obesity, metabolic syndrome, and hypertension, experimenting with salt intake is warranted, but be careful not to go too low because, remember, there is a U-shaped curve when it comes to salt, sodium, and cardiovascular disease risk. Very low sodium intake is associated with higher risk of cardiovascular disease just as very high sodium intake is.

Okay, that's it for this presentation. See you next time.