NutriPATH
INTEGRATIVE PATHOLOGY SERVICES
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SARAH WILLIAMS
15-Aug-1990 Female

409/15 FREEMAN LOOP
FREMANTLE NORTH WA 6159

-.JAIME O'SULLIVAN
PO BOX 200
CLAREMONT WA 6010

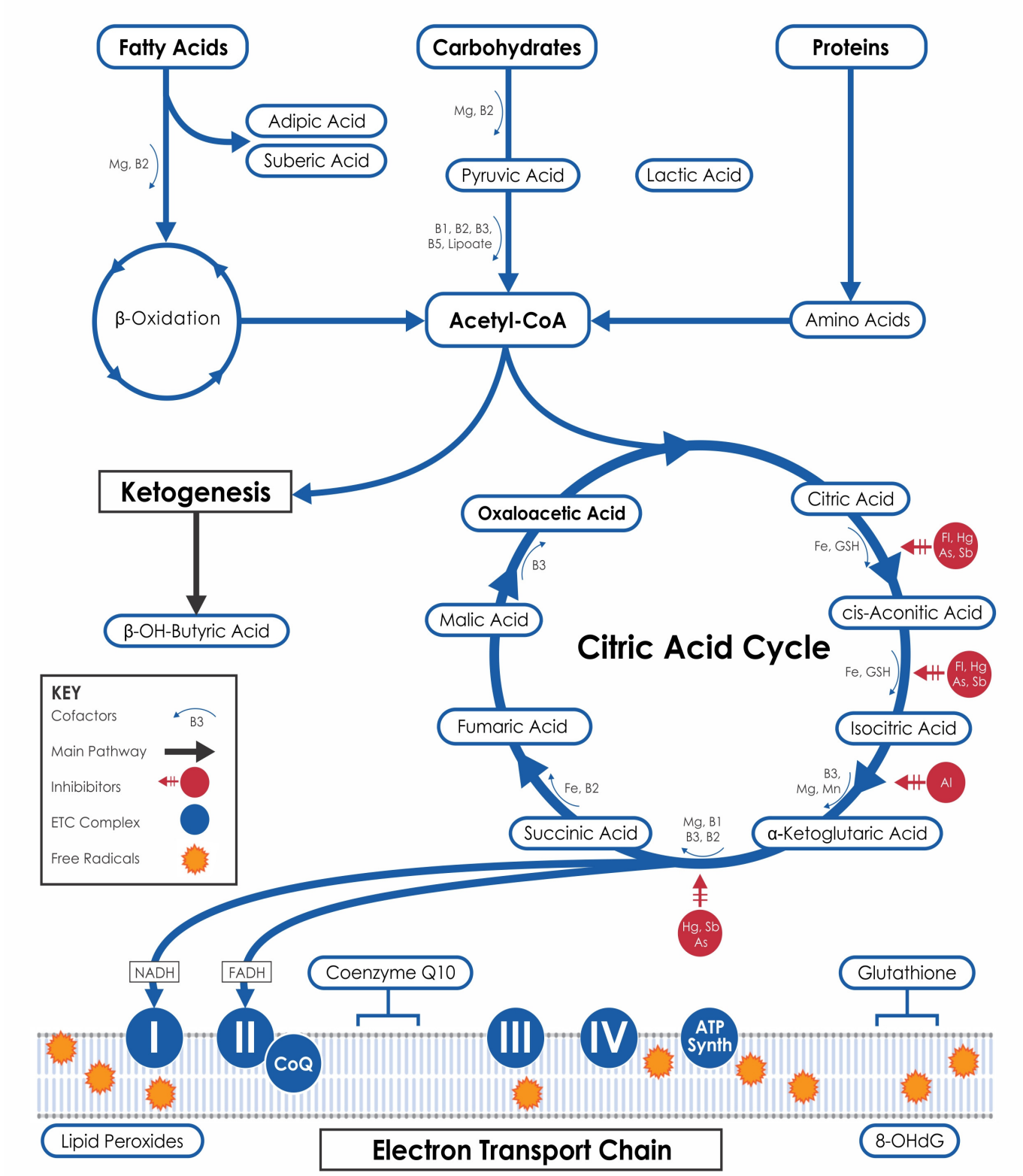
LAB ID : 4002586
UR NO. : 6285112
Collection Date : 08-Jul-2024
Received Date: 10-Jul-2024

4002586

ORGANIC ACIDS METABOLOMIC MAPPING

Method: LCMS/MS/MS

Organic Acids Pathways



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Nutrient Markers

URINE, SPOT

KETONE/FATTY ACID Metabolites
(Carnitine & B2)

1.	Adipic Acid.	0.32	0.00 - 4.07	ug/mgCR	
2.	Suberic Acid.	2.24	0.00 - 2.90	ug/mgCR	
3.	Ethylmalonic Acid	*4.60* *H	0.00 - 2.83	ug/mgCR	
4.	Pimelic Acid	2.0	0.0 - 3.0	ug/mgCR	
5.	Methyl-Succinic Acid	2.25	0.00 - 4.92	ug/mgCR	

CARBOHYDRATE Metabolism/Glycolysis
(B1, B3, Cr, Lipoic Acid, CoQ10)

6.	Pyruvic Acid.	2.30	0.00 - 8.11	ug/mgCR	
7.	Lactic Acid.	*32.40* *H	0.00 - 23.08	ug/mgCR	
8.	b-OH-Butyric Acid	1.53	0.00 - 10.79	ug/mgCR	
9.	Glucose (OA)	<0.1	0.1 - 1.1	mmol/L	

CITRIC ACID CYCLE Metabolites.
(B Comp., CoQ10, Amino Acids, Mg)

10.	Citric Acid.	373.9	132.5 - 645.6	ug/mgCR	
11.	cis-Aconitic Acid.	53.4	37.3 - 153.3	ug/mgCR	
12.	Isocitric Acid.	27.9	19.0 - 79.2	ug/mgCR	
13.	a-Ketoglutaric Acid.	6.08	0.00 - 21.72	ug/mgCR	
14.	Succinic Acid	24.75	1.88 - 27.59	ug/mgCR	
15.	Fumaric Acid.	0.47	0.18 - 2.07	ug/mgCR	
16.	Malic Acid.	0.16	0.00 - 3.59	ug/mgCR	
17.	b-OH-b-Methylglutaric Acid	2.06	0.00 - 4.29	ug/mgCR	

B-Complex Vitamins & Amino Acid Markers
(B1, B2, B3, B5, B6, Biotin)

18.	a-Ketoisovaleric Acid	0.17	0.00 - 1.15	ug/mgCR	
19.	a-Ketoisocaproic Acid	0.17	0.00 - 0.34	ug/mgCR	
20.	a-Keto-b-Methylvaleric Acid	0.35	0.00 - 1.52	ug/mgCR	
21.	Xanthurenic Acid	0.56	0.00 - 0.93	ug/mgCR	
22.	beta-Hydroxyisovaleric Acid	5.70	0.00 - 9.16	ug/mgCR	

METHYLATION COFACTORS
(B12, Folate)

23.	Methylmalonic Acid.	0.91	0.00 - 1.85	ug/mgCR	
24.	Formiminoglutamic Acid **	3.3	0.0 - 5.1	ug/mgCR	

Cell Regulation Markers

NEUROTRANSMITTER METABOLISM
(Tyrosine, Tryptophan, B6, Antioxidants)

25.	Homovanillic Acid (HVA)	2.66	2.39 - 14.92	ug/mgCR	
26.	Vanillylmandelic Acid (VMA)	2.51	1.40 - 5.09	ug/mgCR	
27.	5HIAA	0.34	0.34 - 3.98	ug/mgCR	
28.	Kynurenic Acid.	0.58	0.00 - 1.51	ug/mgCR	
29.	Quinolinic Acid (OA)	*10.94* *H	0.00 - 9.74	ug/mgCR	
30.	Picolinic Acid	<dl	0.0 - 1.5	ug/mgCR	
31.	Cortisol (OA)	17.4	5.0 - 65.0	ng/mL	

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Oxidative Damage/AntiOxidant Markers
(Vitamin C and Other Antioxidants)

32.	ParaHydroxyphenyllactate	0.44	0.00 - 1.47	ug/mgCR	
33.	8 OH-deoxyguanosine	1.2	0.0 - 12.0	ng/gCR	

Toxicants and Detoxification

DETOXIFICATION INDICATORS
(Arg, NAC, Met, Mg, Antioxidants)

34.	2-Methylhippuric Acid	<dl	0.00 - 0.05	ug/mgCR	
35.	Orotic Acid.	0.25	0.00 - 1.09	ug/mgCR	
36.	Glucaric Acid.	6.64	0.00 - 15.18	ug/mgCR	
37.	a-OH-Butyric Acid	0.52	0.00 - 4.16	ug/mgCR	
38.	Pyroglutamic Acid.	7.5	5.3 - 15.7	ug/mgCR	

Compounds of Bacterial or Yeast/Fungal Origin

BACTERIAL DYSBIOSIS MARKERS.

39.	Benzoate (OA)	2.95	0.00 - 7.00	ug/mgCR	
40.	Hippurate (OA)	161	0.0 - 237	ug/mgCR	
41.	Phenylacetate	<dl	0.0 - 0.4	ug/mgCR	
42.	Phenylpropionate	<dl	0.0 - 0.2	ug/mgCR	
43.	ParaHydroxyBenzoate	0.3	0.0 - 2.0	ug/mgCR	
44.	p-HydroxyPhenylacetate	0.4	0.0 - 1.5	ug/mgCR	
45.	Indoleacetic Acid	<dl	0.0 - 6.8	ug/mgCR	
46.	Tricarballylate	0.27	0.00 - 1.97	ug/mgCR	

L. acidophilus/General Bacteria

47.	D-Lactate	*13.8* *H	0.0 - 7.7	ug/mgCR	

CLOSTRIDIAL SPECIES

48.	Dihydroxyphenylpropionic Acid	<dl	0.00 - 0.72	ug/mgCR	
49.	4-Cresol	1.2	0.0 - 1.7	ug/mgCR	
50.	3-OH-Proprionic Acid	5.9	0.0 - 6.1	ug/mgCR	

YEAST/FUNGAL DYSBIOSIS MARKERS.

51.	Arabinitol	4.3	0.0 - 79.5	ug/mgCR	
52.	Citramalic Acid	1.5	0.0 - 8.4	ug/mgCR	
53.	Tartaric Acid.	2.9	0.0 - 16.5	ug/mgCR	

Oxalate Metabolites

54.	Oxalic Acid	6.59	3.15 - 41.69	ug/mgCR	
55.	Glyceric Acid	0.5	0.2 - 0.9	ug/mgCR	
56.	Glycolic Acid	19.3	13.5 - 85.9	ug/mgCR	

Nutritional Markers

57.	Pyridoxic Acid (Vit B6)	1.8	0.7 - 20.3	ug/mgCR	
58.	Pantothenic Acid (Vit B5)	2.1	0.5 - 7.4	ug/mgCR	
59.	Glutaric Acid (Vit B2) **	0.3	0.3 - 1.2	ug/mgCR	
60.	Ascorbic Acid (Vit C)	*0.4* *L	0.9 - 135	ug/mgCR	
61.	CoEnzyme-Q10 (CoQ10) **	1.77	1.27 - 4.29	ug/mgCR	
62.	N-Acetylcysteine (NAC)	*0.11* *L	0.15 - 0.83	ug/mgCR	
63.	Biotin (Vit H)	4.50	1.06 - 6.66	ug/mgCR	

Creatinine, Urine Spot.	8.6	2.5 - 19.2	mmol/L	

Results reported as <dl = Less than detectable limit *** A high value for this marker may indicate a deficiency of this vitamin*

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Nutritional Guide

Nutrient	Adult Dose Range	Units	Clinician Notes
Vitamin-C	1500.0	mg	
Vitamin-B1	150.0	mg	
Vitamin-B2	200.0	mg	
Vitamin-B3	500.0	mg	
Vitamin-B5	200.0	mg	
Vitamin-B6	150.0	mg	
Biotin.	37.5	ug	
Folinic Acid.	400.0	ug	
Chromium .	200.0	ug	
Magnesium .	600.0	mg	
Coenzyme Q10.	300.0	mg	
alpha Lipoic Acid.	600.0	mg	
Acetyl-L-Carnitine.	600.0	mg	
N-Acetylcysteine.	600.0	mg	
5-hydroxyTryptophan (5-HTP).	50.0	mg	
L-Arginine.	2000.0	mg	
Glycine .	1000.0	mg	
Serine.	1500.0	mg	
Tryptophan.	300.0	mg	
Probiotics (Multistain)	15.5	billion CFU	
D-Lactate-free probiotics	60.0	billion CFU	

Disclaimer:

Supplement recommendations are based on the Organic Acid test results. The prescribing health practitioner must take into consideration the age, weight, sex, and pregnancy or lactation state. In addition, consider clinical state, medication regime, associated drug-nutrient depletion and allergies. The doses listed above are considered optimal, based on lab results and do not apply to specific disease conditions where doses may need to be altered. The vitamins, minerals or amino acids listed are elemental quantities. Use clinical discretion when choosing the right salt with the guidance of your compounding health professional. For example, Magnesium may be prescribed as a glycinate for its calming effect or threonate may be used for a Magnesium that crosses the blood-brain-barrier.

References:
Laboratory Evaluations for Integrative and Functional Medicine by Richard Lord.
J.Alexander Bralley; Textbook of Nutritional Medicine by Alan Gaby.

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Laboratory Comments

Ketone/FA Metabolites Comment

Organic acids provide functional markers for the metabolic effects of micronutrient adequacy, toxic exposure, neuroendocrine activity, intestinal bacterial and fungal overgrowth. Organic acid testing indicates the need for nutrients, diet modification, detoxification, antioxidant protection or further testing.

In a healthy state, organic acids are excreted in the urine at low concentrations. Low range results may be associated with hypometabolic compensatory states. Compensatory responses include hormonal secretions and cytokine responses that can slow or reverse deviations from median or normal physiologic states.

The Krebs cycle is a process of conversion of fats, carbohydrates and protein to mitochondrial energy, ATP.

Metabolic blocks in the Krebs cycle due to insufficient enzymes or cofactors will result in the elevation of organic acids that accumulate and spill into urine.

FATTY ACID METABOLISM:
Adipate, suberate, pimelate, Ethylmalonate and 2-methylsuccinate are organic compounds from fatty acid metabolism. Long chain fatty acids (LCFAs) undergo beta-oxidation in the mitochondria which is carnitine dependant. Dietary fat is broken down to produce free fatty acids, energy substrates using pathways that require carnitine and vitamin B2 (Riboflavin).
Low levels of Ethylmalonate with high adipate and suberate may be associated with carnitine deficient hypometabolic states where multiple amino acid catabolic pathways are restricted due to mitochondrial retraction.

ETHYLMALONATE ELEVATED:
Ethylmalonic Acid is a functional marker of carnitine insufficiency. It may be formed when short chain fatty acid oxidation is compromised, which causes an elevation of butyrate, some of which is converted to ethylmalonate.
This oxidation is dependent on formation of acylcarnitine.
Causes:
Carnitine deficiency, Riboflavin deficiency, failure in formation or oxidation of butyrylacrnitine, genetic mutations (short chain acyl-CoA dehydrogenase, multiple acyl-CoA dehyrdrogenase), Isoleucine loading, Toxicant exposures.
Symptoms/conditions:
Periodic mild weakness, Mitochondrial dysfunction, Nausea, Fatigue, Hypoglycemia, Recurrent infections, Attention defici in children, Metabolilc acidosis, Reye syndrome (inhibition of fatty acid oxidation likely caused by aspirin in presence of a genetic mutation given for viral infection-viral toxins also implicated).
Supplementation Recommendations:
B complex (B2, B5), CoQ10, L-Carnitine (may be contraindicatedin patients on thyroid medications), L-Lysine (precursor to L-Carnitine), Other nutrients involved in Carnitine synthesis (Mg, SAMe, Vit B6, ascorbic acid, iron, niacin)
Also: Glycine, 250mg/kg/day, Avoid medium chain fatty acids such as coconut oil.

Carbohydrate Metabolism Comment

CARBOHYDRATE METABOLISM/GLYCOLYSIS:
Dietary carbohydrates are broken down into Glucose and other sugars where carbohydrate breakdown products, pyruvate and lactate are formed. Pyruvate enters the Krebs cycle via dehydrogenase enzymes which require vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B5 (pantothenic acid), and lipoic Acid to function correctly. Review Vitamin B Levels in conjunction with Pyruvate and Lactate levels.

In the absence of these nutrients, lactate builds up leading to lactic acidosis. Elevated pyruvate and lactate can indicate a need for lipoic acid.

LACTATE ELEVATED:

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This metabolic precursor to the Citric Acid Cycle, may indicate a block in the production of energy due to mitochondrial disorders, an on-going infectious state, use of some recreational and/or pharmaceutical drugs, alcohol over-consumption, poor blood sugar control (especially with diabetics), and a number of inborn errors of metabolism.
Supplementation Recommendations:
B Vitamins (B1, B2, B3, B5), lipoic acid, and CoQ10.

LACTATE ELEVATED:
This metabolic precursor to the Citric Acid Cycle, may indicate a block in the production of energy due to mitochondrial disorders, an on-going infectious state, use of some recreational and/or pharmaceutical drugs, alcohol over-consumption, poor blood sugar control (especially with diabetics), and a number of inborn errors of metabolism.
Supplementation Recommendations:
B Vitamins (B1, B2, B3, B5), lipoic acid, and CoQ10.

Cit Acid Cycle Metabs Comment

The Citric Acid Cycle is the pathway for energy released from food components and the source of anabolic molecules to support organ maintenance and neurological function. Therefore, the citric acid cycle serves both anabolic and catabolic functions representing the crossroads of food conversion and utilisation.

B-Vitamins/Amino Acids Comment

B-COMPLEX VITAMIN MARKERS:
B-Complex Vitamin Markers are metabolic intermediates in the degradation of amino acids. When hepatic enzymes remove branched-chain amino acids, they form keto acids.
B-complex vitamins are essential for many in metabolic functions in the body used to extract energy from cellular health, remove toxins, and maintain the immune system.
B-Complex vitamin deficiencies produce symptoms associated with homocysteinemia effects or mitochondriopathy-associated symptoms which include periodic weakness, nausea, fatigue, attention deficit or Reye syndrome.

Neurotransmitter Metabolism Comment

5HIAA IS WITHIN RANGE:
5HIAA is the major metabolite of Serotonin.

QUINOLINOLATE ELEVATED:
- Produced from L-tryptophan in interferon gamma (IFN-g)-stimulated macrophages via the kynurenine pathway.
- Functions in immune system modulation of brain activity
- Quinolinate is a powerful agonist of the NMDA receptors, ultimately leading to glutamate toxicity
- In inflammatory diseases, a high Quinolinate:Kynurenate (QUIN/KYNA) ratio increases risk of neurotoxicity
- May be elevated by L-tryptophan, but not by 5-hydroxytryptophan loading.
Causes:
- Disordered tryptophan metabolism
- Chronic stimulation of the immune response: causes release of INF-g by macrolphages
- Results in tryptophan conversion to quinolinate by astrocytes and microglia in CNS
- HIV -related neurological dysfunction: Due to overstimulation by quinolinate of the NMDA receptors. Causes subsequent neurological degeneration with permanent loss of brain function.
- Microbial Infections: Bacterial infection (recent or chronic), Fungal and parasitic infections, Viral infection, recent or chronic
- Gastrointestinal infections (recent or chronic) leading to Auotimmune disease, Inflammatory bowel diseases
- Meningitis
- Septicemia
- Chronic hyperammonemia
- Symptoms/Conditions:
Viral infection, Irritable bowel disease, Neurodegenerative conditions, Memory deficits, Insomnia, Chronic

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fatigue syndrome
Supplementation Recommendations:
Antioxidants (Vitamin C, Vitamin E, lipoic acid), Magnesium, Glycine, 50, Resolve inflammatory stimulation.

ELEVATED Quinolinic Acid /5HIAA/ Ratio
Possible Tryptophan Steal Effect.
Tryptophan is the essential precursor for endogenous NAD and Serotonin biosynthesis. About 1-2% of dietary tryptophan is converted to serotonin. However, the kynurenine pathway is the most tryptophan-consuming metabolic pathway with about 95% of the ingested tryptophan entering the kynurenine pathway, which can result in the production of NAD, as well as other metabolites (kynuramines, kynurenic acid, quinolinic acid). Kynurenine acid has anxiogenic effects while quinolinic acid is highly neurotoxic and as such are undesirable in high levels.

Tryptophan oxidation to kynurenine (preferentially) is catalyzed by 2 enzymes, and induced by different mechanisms;
1. Tryptophan Dioxygenase (TDO), hepatically which generates NAD.
   TDO is induced by corticosteroids and glucagon (Stress/Hypoglycaemia).
2. Indoleamine 2,3 Dioxygenase (IDO), extrahepatically.
   IDO activity (normally negligible) can become highly inducible by pro-inflammatory cytokines, including IFN-gamma and TNF-alpha (Inflammation).

5HTP is also preferentially shunted from Serotonin production to act as a substrate for TDO and IDO.

For the de novo NAD synthesis pathway to be completed it is necessary to have adequate levels of the following;
Riboflavin (vitamin B2), Pyridoxyl phosphate (vitamin B6), and Ascorbate (vitamin C).
Deficiencies in any of these can lead to the accumulation of "kynurenine pathway" Intermediates.

Treatment Recommendations:
Treat possible SIBO, Yeast Overgrowth, Oxalate issues.
Normalise sugar levels (avoid daytime fasting, high glycaemic foods)
Manage stress (avoid hypoglycaemia, over-training, optimize sleep habits)
Reduce inflammation (leaky gut support, EFAs, anti-inflammatories, dysbiosis)
Consider Nutritional support (Vits B3, B2, B6, C)

Detoxification/Toxicants Comment

OXIDATIVE DAMAGE AND ANTIOXIDANT MARKERS:
The assessment of protection from oxidant and ammonia challenge should be of priority when detoxification requirement is suspected. Oxidative stress has been associated with a variety of diseases like diabetes, cancer, neurodegenerative disorders and aging.

DETOXIFICATION INDICATORS:
The organic acids of this group serve as biomarkers of detoxification status or biotransformation capacities, distinct parts of the detoxification system, providing insight about both exogenous toxin accumulation and endogenous detoxification responses.
Elevations in toxicant and detoxification markers reveal aspects of xenobiotic exposure, endogenous toxins and detoxification functions.

Nutritional Markers Comment

ASCORBIC ACID (Vit C) LOW:
Ascorbic acid is a powerful antioxidant involved in metallothionation of iron and copper, synthesis of collagen, carnitine and neurotransmitters, noradrenaline and tryptophan. Deficiency of Vitamin C is associated with scurvy, skin haemorrhages, gum disease, arthralgia and mood changes.
Supplementation Recommendations:
Adult Repletion: 1000-5000mg

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N-ACETYLCYSTEINE (NAC) LOW:
Cysteine, a sulphur-containing amino acid are found at many catalytic sites of many enzymes and turnover of glutathione. Cysteine rich protein, keratin is found in hair. NAC helps to replenish glutathione levels in the body, assists in detoxification in liver and kidney, relieves respiratory disorders, and improves mood. It also aids in regulating glutamate. NAC supplementation is associated side effects of dry mouth, nausea, vomiting, and diarrhoea.
Supplememntation Recommendations:
Adult Repletion: 200-600mg