Case Report: Utilization of Urinary Neurotransmitter Metabolite Testing and Natural Supplements in the Management of Disordered Eating

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Diagnosing and treating mental health disorders can be challenging. Healthcare providers do their best to assess symptoms and predict which drug(s) may provide the patient with relief. Symptoms of individual neurotransmitter imbalances sometimes overlap, making it difficult for the provider to know where to target pharmacological treatment. The measurement of neurotransmitter urinary metabolites before initiating an intervention possesses great potential as a significant clinical tool.

CLINICAL FEATURES

The purpose of this case report is to demonstrate the effectiveness of estimating brain neurotransmitters via urinary metabolites and using targeted supplementation to aid in the management of mental health issues such as eating disorders. In August of 2021, the 34-year-old female patient took the Labrix / Doctor's Data Neurohormonal Complete Plus Panel, which also analyzed her stress hormone, cortisol, as well as her sex hormone levels. For the sake of this case report we will limit the discussion to the neurotransmitter component of the exam. We received the results in September of 2021 and she began a supplement regimen in the same month.

INTERVENTION AND OUTCOME

Following the targeted supplement regimen, the patient reported subjectively feeling like she had more energy after 1 week but after 2 weeks she stated, "I feel like a new person. I feel like I have control." Objectively, the patient went from 100 pounds to 108 pounds in 5 months; her BMI increased from 17.2 to 18.5 in that same time period. In January of 2022, she retested the urinary neurotransmitter metabolites. The positive effects of natural supplements on neurotransmitter levels are objectively evidenced by the second neurotransmitter metabolite urine test.

CONCLUSION

The pharmacological management of mental health issues is archaic at best. Analyzing urinary neurotransmitter metabolites is an easy and cost-effective way to objectively estimate brain function. This case report demonstrates improved outcomes when testing patients prior to prescribing psychotropic drugs or natural supplements to optimize brain neurotransmitter levels. Further studies with a larger number of participants are needed in order to bring this into clinical practice.

KEYWORDS: Eating Disorders, Bulimia, Neurotransmitters, Urinary Metabolite Testing, Neurotransmitter Testing, Mental Health

INTRODUCTION

The aim of this case report is to show that testing neurotransmitters prior to initiating intervention yields a more successful outcome because the patient only takes the targeted supplements that they need for each analyte. A successful outcome is defined, in this case, to be physical attributes such as weight and BMI, as well as psychosocial attributes such as improved overall sense of well-being and "feeling normal." Retesting also shows more balanced neurotransmitter urinary metabolites after targeted nutraceutical intervention. This is favorable to the patient as it eliminates the risk of inadvertently pushing brain chemicals in the wrong direction and exacerbating the mental health condition, which is a risk that a patient is subjected to when receiving the current standard of care.

Of all mental health disorders, eating disorders, particularly anorexia nervosa, carry the highest death rates, exceeding the death rate for depression.[1,2] Primary care providers are often the first line of response, yet report incompetency when faced with the task of managing eating disorders.[3] A systematic review showed that individuals with eating disorders report that primary care providers lacked experience, understanding, or knowledge of the disorder. Consequently, diagnoses are made only when the physical symptoms became severe.2 The longer a patient is sick with an eating disorder, the less likely they are to make a full recovery.[1,4]

An alternative to primary care intervention would be specialist services. However, this can be challenging for the patient. Two main reasons that specialist services may be unavailable to the patient are, lack of affordability and the specialist programs may be limited in the number of patients that they can receive for treatment.[1] Another roadblock to recovery is that specialist services and treatment programs typically focus on BMI, body weight, and food intake as measures for recovery. Research shows that individuals with eating disorders define recovery based on psychological

markers such as well-being and "feeling normal."[1,2] This disconnect between patient and provider perpetuates the illness and decreases the likelihood of full recovery, especially if there is no aftercare plan.

CASE PRESENTATION

The patient was a well-mannered, underweight, 34-year-old Italian-American woman of a higher socio-economic level. A detailed history was taken and of note was that she

TABLE 1: INITIAL TEST RESULTS AUGUST 25, 2021 (DOCTOR'S DATA)

Client #: 44854
Doctor: Will Blankenship, MD
Evexia Diagnostics
18 Titus Rd
Washington Depot, CT 06794 U.S.A.

Age: 34 **DOB:** 07/10/1987
Sex: Female
Body Mass Index (BMI): 17

Date Received 08/25/2021
Date Reported 08/30/2021

Analyte	Result	Unit per Creatinine	L	WRI	H	Reference Interval
Serotonin	47.5	µg/g				60 – 125
Dopamine	164	µg/g				125 – 250
Norepinephrine	7.0	µg/g				22 – 50
Epinephrine	0.8	µg/g				1.6 – 8.3
Norepinephrine / Epinephrine ratio	8.8					< 13
Glutamate	51	µmol/g				12.0 – 45.0
Gamma-aminobutyrate (GABA)	4.2	µmol/g				2.0 – 5.6
Glycine	1988	µmol/g				450 – 2200
Histamine	34	µg/g				14 – 44
Phenethylamine (PEA)	99	nmol/g				32 – 84
Creatinine	47.0	mg/dL				30 – 225

TABLE 2: FOLLOW-UP TEST RESULTS JANUARY 21, 2022 (DOCTOR'S DATA)

Serotonin levels were elevated due to the patient accidentally taking 50 mg 5-HTP and 100 mg 5-HTP, instead of the recommended 50 mg 5-HTP. Norepinephrine and Epinephrine levels doubled and tripled, respectively. Once the patient reduced supplemental 5-HTP, the Epinephrine and Norepinephrine were expected to continue to rise.

Client #: 44854
Doctor: Will Blankenship, MD
Evexia Diagnostics
18 Titus Rd
Washington Depot, CT 06794 U.S.A.

Age: 34 **DOB:** 07/10/1987
Sex: Female
Body Mass Index (BMI): 27

Date Received 01/21/2022
Date Reported 01/26/2022

Analyte	Result	Unit per Creatinine	L	WRI	H	Reference Interval
Serotonin	304	µg/g				60 – 125
Dopamine	227	µg/g				125 – 250
Norepinephrine	15.0	µg/g				22 – 50
Epinephrine	2.3	µg/g				1.6 – 8.3
Norepinephrine / Epinephrine ratio	6.5					< 13
Glutamate	16	µmol/g				12.0 – 45.0
Gamma-aminobutyrate (GABA)	3.1	µmol/g				2.0 – 5.6
Glycine	998	µmol/g				450 – 2200
Histamine	14	µg/g				14 – 44
Phenethylamine (PEA)	49	nmol/g				32 – 84
Creatinine	126	mg/dL				30 – 225

had tried many different treatment options over the years. Her medical findings were unremarkable, and she still had no answers from her previous doctors.

The patient admitted that she had stopped being bulimic for a year but was still battling the mental aspect of disordered eating patterns. The patient described, "It's all about control. I wanted to see how far I could take it, how much I could restrict myself. It was all a game in my head." Although the patient may have stopped purging after meals, further provoking during my initial evaluation concluded that she had morphed into what is referred to as an exercise bulimic. She was exercising 2-3 hours per day, every day!

Serotonin levels were elevated due to the patient accidentally taking 50 mg 5-HTP and 100 mg 5-HTP, instead of the recommended 50 mg 5-HTP. Norepinephrine and Epinephrine levels doubled and tripled, respectively. Once the patient reduced supplemental 5-HTP, the Epinephrine and Norepinephrine were expected to continue to rise.

SEROTONIN

Serotonin is unique because up to 95% is made in our gut, and a small amount is transported by our blood platelets. The remaining 5% is synthesized by neurons, mostly in the brain but also in pancreatic islets, mammary glands, and adipose tissue.[5] Some of it eventually converts to melatonin in the brain.[5] Serotonin helps us with sleep, appetite, sex, aggression, digestion, mood stabilization, cognitive function, anxiety, impulse control, reward processing, learning, memory, and managing irritability.[6] Deficits in the synthesis of serotonin can result in various pathological conditions, particularly depression, schizophrenia, mood disorders, and autism.[7]

Many prescription anti-depressants are selective serotonin reuptake inhibitors (SSRIs).[8] One barrier to recovery that exists with conventional primary care providers or psychologists is that they most likely prescribe an SSRI based on a patient's symptoms without first testing serotonin levels; however, the symptoms of high and low serotonin can be similar. Theoretically, if a patient has high serotonin already and starts taking an SSRI, their symptoms may get worse. If the doctor increases the dosage or has the patient try a different SSRI, the symptoms may continue to worsen. It is known in the literature that results from testing urinary metabolites have been shown to correspond to symptoms of depression.[9] For this reason, it is beneficial for patients to spend money on testing.

Diet and lifestyle are major determinants of chronic diseases. How diet alters gene expression, also known as the nutrigenomics field, is rapidly expanding. It is now known that food affects epigenetic modifications.[10,11] Since most serotonin is synthesized in the gut, good nutrition is paramount to having healthy serotonin levels. There is a need to rule out gut dysbiosis as a contributor; food sensitivities like dairy, gluten, corn, and soy can play a part in poor digestive health. It is true that depression is congenital,[12] but having poor gut health may be equally contributory.[13] The bidirectional communication between the gut and central nervous system is likely implicated in the high comorbidity rates between psychiatric and gastrointestinal illnesses.[14] A patient may have inherited depression but will either help keep control of it with a good diet and exercise or exacerbate it with a poor diet high in sucrose, refined carbohydrates, and bad fats.

Symptoms of low serotonin include decreased engagement in social activities, appetite changes, anorexia, fluctuating body temp, aches/pains, cramps, bowel/bladder issues, smothering sensations, numbness, flat affect, crying/angry outbursts, thoughts of escaping current circumstances, obsessive/compulsive traits, paranoia about germs, racing or troublesome thoughts.[15,16]

Low Serotonin Supplements and Lifestyle Modifications (Intervention):

1. 5-HTP 100 mg/day for 3 months and then reduce to 50 mg/day. This is to be taken on an empty stomach as soon as the patient wakes up.9
2. L-Theanine 400 mg/day.17,18
3. Vitamin D 4000 IU/day; this won't absorb if the patient has gut dysbiosis.19 Preferably, the patient will get 15 minutes per day of sun exposure also.
4. Multivitamin with copper, iron, and zinc.
5. Exercise, meditation, sunlight, music therapy, avoid gluten, and eat a whole foods diet. The patient did not give up bread and pasta.

According to the lab, the normal range of serotonin is 60-125 µg/g creatinine. The patient tested at 47.5 µg/g creatinine (low) on August 25, 2021, and 304 µg/g creatinine (high) on January 21, 2022. Instead of reducing to 50 mg per day after 3 months, the patient misunderstood the instructions and was taking 150 mg per day for 2 months prior to the second test. Hence, the elevated serotonin level during the retest.

DOPAMINE

Dopamine is mostly made in the Basal Ganglia region of the brain and a small amount is made in the adrenal medulla. Low dopamine levels are associated with diseases like schiz-

ophrenia, Attention Deficit Hyperactivity Disorder (ADHD), autism, restless leg syndrome,[20] pain syndromes, and Parkinson's.[21] Dopamine affects our mood, cognitive function, attention, appetite, sex, aggression, reward, pleasure, motivation, and drive.[22] Dopamine enhances the reward response, enables us to not only see rewards but take action to move toward them, and stimulates pleasure centers, locomotion, and coordination of movement.

Some symptoms of low dopamine include pleasure-seeking behaviors or addictions, decreased mood or apathy, fatigue or sleepiness, and Parkinson-like symptoms such as tremors, stiff legs, gait dysfunction, and slow reaction time.

Low Dopamine Supplements and Lifestyle Modifications (Intervention):

1. L-Tyrosine 1200 mg daily, taken on an empty stomach as soon as the patient wakes up.23
2. L-Theanine 400 mg daily, taken on an empty stomach as soon as the patient wakes up.17,18
3. Macuna Pruriens 500 mg daily, taken on an empty stomach as soon as the patient wakes up.24
4. Multivitamin with copper and iron to be taken with breakfast so the iron doesn't delay sleep onset or upset the stomach. Taking zinc for low serotonin can reduce copper over time, which will eventually reduce norepinephrine production. Please refer to Table 4 to visualize co-factors needed for the production of enzymes and neurotransmitters.
5. Vitamin D 4000 IU/day and also try to go outside to get 15 minutes of sunlight per day.
6. Vitamin C 4-6 g/day (4000-6000 mg/day) take the Liposomal C and preferably eat fruits/veggies for natural sources of vitamin C also.

According to the lab, the normal range of dopamine is 125-250 µg/g creatinine. The patient tested 164 µg/g creatinine (normal) on August 25, 2021, and 227 µg/g creatinine (normal) on January 21, 2022, following the above-recommended supplement regimen. The patient supplemented to increase dopamine levels even though she initially tested on the low end of normal with 164 µg/g creatinine because dopamine is the precursor to norepinephrine and her norepinephrine levels are low. See Table 4.

NOREPINEPHRINE AND EPINEPHRINE

Norepinephrine is made in the locus coeruleus area of the brain when it acts as a neurotransmitter and also made in the adrenal medulla when it acts as a hormone.[25] Norepinephrine is constantly released at low levels in response to short-term stress.[26] Epinephrine (Adrenaline) is released during times of stress, cold, hypoglycemia, or as part of the sympathetic response; it causes increased blood pressure via vasoconstriction of blood vessels and increased cardiac output, as well as increased blood glucose levels. Norepinephrine plays a role in our mood, cognitive function, attention, anxiety, impulse control, irritability, alertness, sleep-wake cycle, concentration, and overall energy levels.[27]

Some symptoms of low norepinephrine/epinephrine are hypotension, ADHD, poor attention and memory, decreased concentration, decreased socialization, decreased alertness, brain fog, depression, pain, lack of arousal & interest, may self-medicate and have a reputation as an "adrenaline junky."

S-Adenosyl Methionine (SAMe) levels decrease with aging which can lead to impaired methylation, which has been associated with the onset of osteoarthritis, liver diseases, cardiovascular diseases, depression, and neurodegenerative diseases such as Alzheimer's disease.[28,10,29,32,30,31] Studies support the use of exogenous SAMe supplementation to improve methylation and modulate symptom presentation in neurodegenerative disease management;[10] supplemental SAMe is able to cross the blood-brain barrier[33,34,10,30] and assist in the management of mood disorders due to its role in the synthesis of acetylcholine, epinephrine, melatonin, norepinephrine, dopamine, serotonin.[10, 35]

Low NE/Epinephrine Supplements (Intervention):

1. L-Tyrosine 1200 mg daily taken on an empty stomach upon waking.23
2. Macuna Pruriens (L-Dopa) 500 mg daily taken on an empty stomach upon waking.24
3. L-Theanine 400 mg daily taken on an empty stomach upon waking and drink green tea throughout the day for natural sources of L-Theanine.
5. Multivitamin with copper and a methylated B complex.
6. If the patient has low epinephrine and norepinephrine, take Magnesium Malate 400 mg/day.36
7. SAMe 400 mg/day, take in the morning with food in case of stomach upset.36

According to the lab, the normal range of norepinephrine is 22-50 µg/g creatinine. The patient tested 7 µg/g creatinine (low) on August 25, 2021, and 15 µg/g creatinine (low) on January 21, 2022. According to the lab, the normal range of epinephrine is 1.6-8.3 µg/g creatinine. The patient tested 0.8 µg/g creatinine (low) on August 25, 2021, and then 2.3 µg/g creatinine (low) on January 21, 2022. By following the above

supplement regimen, the patient doubled her norepinephrine levels and nearly tripled her epinephrine levels.

NOREPINEPHRINE:EPINEPHRINE RATIO

According to the lab, the normal range for Norepinephrine:Epinephrine ratio is less than 13:1. The patient tested 8.8 on August 25, 2021, and 6.5 on January 21, 2022. No intervention was taken due to the patient being in the normal range.

Epinephrine is synthesized from Norepinephrine so this ratio indicates how well your body is metabolizing the phenylethanolamine N-methyltransferase enzyme for the conversion of Norepinephrine to Epinephrine. This enzyme requires cortisol, magnesium, and SAMe.[10] Norepinephrine works on alpha receptors found in your arteries.[37] Epinephrine works on alpha and beta receptors found in the heart, lungs, and arteries of skeletal muscles to aid in the sympathetic response. Anxiety, burnout, and poor blood sugar control are associated with a relative epinephrine depletion due to their Hypothalamic Pituitary Adrenal axis disruption, and thus an elevated Norepinephrine:Epinephrine ratio. If the ratio is high, we must address adrenal glands, look at the patient's cortisol levels, and supplement accordingly.[38]

GLUTAMATE

Glutamate is the most abundant excitatory neurotransmitter in the brain, often found in food as "glutamic acid" or monosodium glutamate (MSG). Elevated glutamate can be found in anxiety, insomnia, ADHD, poor concentration, seizure, MS, ALS, Alzheimer's, depression,[6] autism, bipolarism, aggression, impulsiveness, antisocial personality disorder,39 and Schizophrenia.[40]

High Glutamate Supplements (Intervention):

1. L-Theanine 400 mg can be taken twice a day, taken on an empty stomach upon waking, and drink green tea throughout the day for natural sources of L-Theanine[17,18]
2. Taurine 1000 mg/day, taken on an empty stomach as soon as the patient wakes up.[41]
3. Magnesium Malate 400 mg daily, taken in the morning with or without food.[42]
4. Methylated B-Complex taken in the morning with or without food, but this is not needed if the patient is also taking a multivitamin that contains B6 and B3.

According to the lab, the normal range for glutamate is 12-45 µmol/g creatinine. The patient tested 51 µmol/g creatinine (high) on August 25, 2021, and 16 µmol/g creatinine (normal) on January 21, 2022, after following the above supplement regimen.

GAMMA-AMINOBUTYRIC ACID (GABA)

GABA aids in the stress response. It is a major inhibitory neurotransmitter, is relaxing and calming[43] and is synthesized from glutamate and B6. GABA is often used to treat anxiety and seizures, is used as a muscle relaxant, and can be used as a sedative; the predominant receptor in the brain is GABA A which is utilized by neuroactive drugs like benzodiazepine.[44]

Elevated GABA levels act as a compensatory mechanism when excitatory neurotransmitters are high[43] and may lead to drowsiness, decreased alertness, difficulty concentrating, decreased memory and cognitive processing, decreased mood, and flat affect; if glutamine levels are high, you also hope that GABA levels are high to compensate.[44]

High GABA Supplement (Intervention):

1. L-Theanine 500 mg taken daily.17,18

According to the lab, the normal range is 2.0-5.6 µmol/g creatinine: the patient tested 4.2 µmol/g creatinine (normal) on August 25, 2021, and then tested 3.1 µmol/g creatinine (normal) on January 21, 2021. No intervention was recommended as the patient was within normal range. The patient was taking L-Theanine for other neurotransmitter imbalances and her glutamate levels decreased in response to the intervention, which may be why her levels reduced.

GLYCINE

Glycine is an amino acid but the body can synthesize it from other chemicals therefore it is not considered an essential amino acid.[45] It supports collagen growth as it's a building block of protein. Glycine assists the liver in bile production. It's an inhibitory neurotransmitter found in the brainstem and spinal cord that participates in the processing of motor and sensory information that permits movement, vision, and audition.[46] In the forebrain it functions as an NMDA receptor co-agonist, it can be excitatory if promoting the action of glutamate or inhibitory if taken before bed.

According to the lab, the normal range is 450-2200 µmol/g creatinine. The patient tested 1988 µmol/g creatinine (normal) on August 25, 2021, and then tested 988 µmol/g creatinine (normal) on January 21, 2022. No intervention was used for the regulation of glycine in this patient, as she was within the normal range. Her levels went from the high end of normal to more mid-range, which is optimal.

HISTAMINE

Histamine is a transmitter in the nervous system and a signaling molecule in the gut, the skin, and the immune system.[47] Mutual interactions with other transmitter systems form a network that links basic homeostatic and higher brain functions, including sleep-wake regulation, circadian and feeding rhythms, immunity, learning, and memory in health and disease. Histamine promotes wakefulness and acts as a neuromodulator since it regulates the release of other neurotransmitters like acetylcholine, norepinephrine, serotonin, and dopamine. Histamine plays a central role in innate and acquired immunity: in allergy and inflammation, closely associated with mast cell functions, in immunomodulation regulating T-cell function and autoimmunity.[47] Histamine also enhances the blood-brain barrier.[48]

Symptoms of high histamine include flushing, itching, asthma, red eyes, urticaria/hives, eczema, facial swelling, headache or migraines, runny nose, nose/sinus congestion, irregular menstrual cycles, abdominal cramping, palpitations, or elevated heart rate above 90 bpm Resting Heart Rate, anxiety, indigestion, nausea, vomiting, dizziness, insomnia or difficulty sleeping.[49]

High Histamine Supplements and Lifestyle Modifications (Intervention):

1. Avoid high histamine-containing foods such as: alcohol-especially champagne, aged cheeses and meats, spinach, eggplant, tomato, vinegar, ketchup, condiments, canned or fermented foods including Kefir and kombucha, smoked meats, chickpeas, shellfish, chocolate, citrus fruits, strawberries, cherries, peanuts, egg whites, etc.[49]
2. Eat fresh meats and fish, fresh fruits and vegetables, and avoid leftovers and alcohol.[49]
3. The breakdown of histamine in the body requires SAMe and copper for proper methylation, so if the patient takes a multivitamin with copper and iron that includes methylated B vitamins, plus 400 mg per day of SAMe, they may be able to reduce their histamine levels.[49]

According to the lab, the normal range for histamine is 14-44 µg/g creatinine. The patient tested 34 µg/g creatinine (normal) on August 25, 2021, and then tested 14 µg/g creatinine (normal) on January 21, 2022. No intervention was recommended for the patient. Being that the patient was on the high end of normal in the first test, the SAMe that was taken for low norepinephrine and epinephrine most likely helped metabolize the histamine to a lower level for the follow-up test.

PHENYLETHYLAMINE (PEA)

2-Phenylethylamine (PEA) is an endogenous trace monoamine, identified in the brain of several mammalian species including humans, and foods such as cheese, cocoa, or wine.[17] While the physiological function of PEA has never been fully established, several studies in the past have focused attention on its amphetamine-like action. PEA is a hormone-like substance that functions as a neurotransmitter that gives you heightened focus, attention, goal-directed behavior, and task completion, it stimulates serotonin, reduces anxiety, and acts as a vasoconstrictor.

Long-term over-consumption of PEA-containing food items could be a neurological risk factor having significant pathological relevance to disease conditions such as depression or motor dysfunction.[33] Symptoms of elevated PEA levels are anxiety, motor discoordination, and amphetamine-like effects, associated with high cortisol levels.

High PEA Supplements and Lifestyle Modifications (Interventions): decrease protein intake, decrease fermented food intake, decrease stress/cortisol levels, and decrease intake of white wine, beer, chocolate, cheese, and other foods high in PEA.

1. Rhodiola 100 mg taken daily.50

According to the lab, the normal range for phenylethylamine is 32-84 nmol/g creatinine. The patient tested 99 nmol/g creatinine (high) on August 25, 2021, and then tested 49 nmol/g creatinine (normal) on January 21, 2022. It was recommended that the patient take Rhodiola daily.

CREATININE

Creatinine is the waste product of creatine, which is what the muscles use to make energy. It travels in the blood to the kidneys and is excreted in urine so if the levels are high, the kidneys may not be working properly.51 Conversely, if the levels are low, it could be due to too much muscle exertion. Symptoms and contributing factors of low creatinine are muscle loss due to not eating enough protein, being vegetarian or vegan, not enough food in general, too frequent or intense physical activity, or kidney dysfunction.

Low Creatinine Lifestyle Modifications (Intervention): decrease the intensity of physical activity levels, eat animal protein more frequently, and drink enough water to support optimal kidney function.

According to the lab, the normal range for creatinine levels is 30-225 mg/dL. The patient tested 47 mg/dL (normal) on August 25, 2021, and then tested 126 mg/dL (normal) on

January 21, 2022. Recommendation to exercise 1 hour or less per day instead of 2-3 hours per day.

DISCUSSION AND CONCLUSION

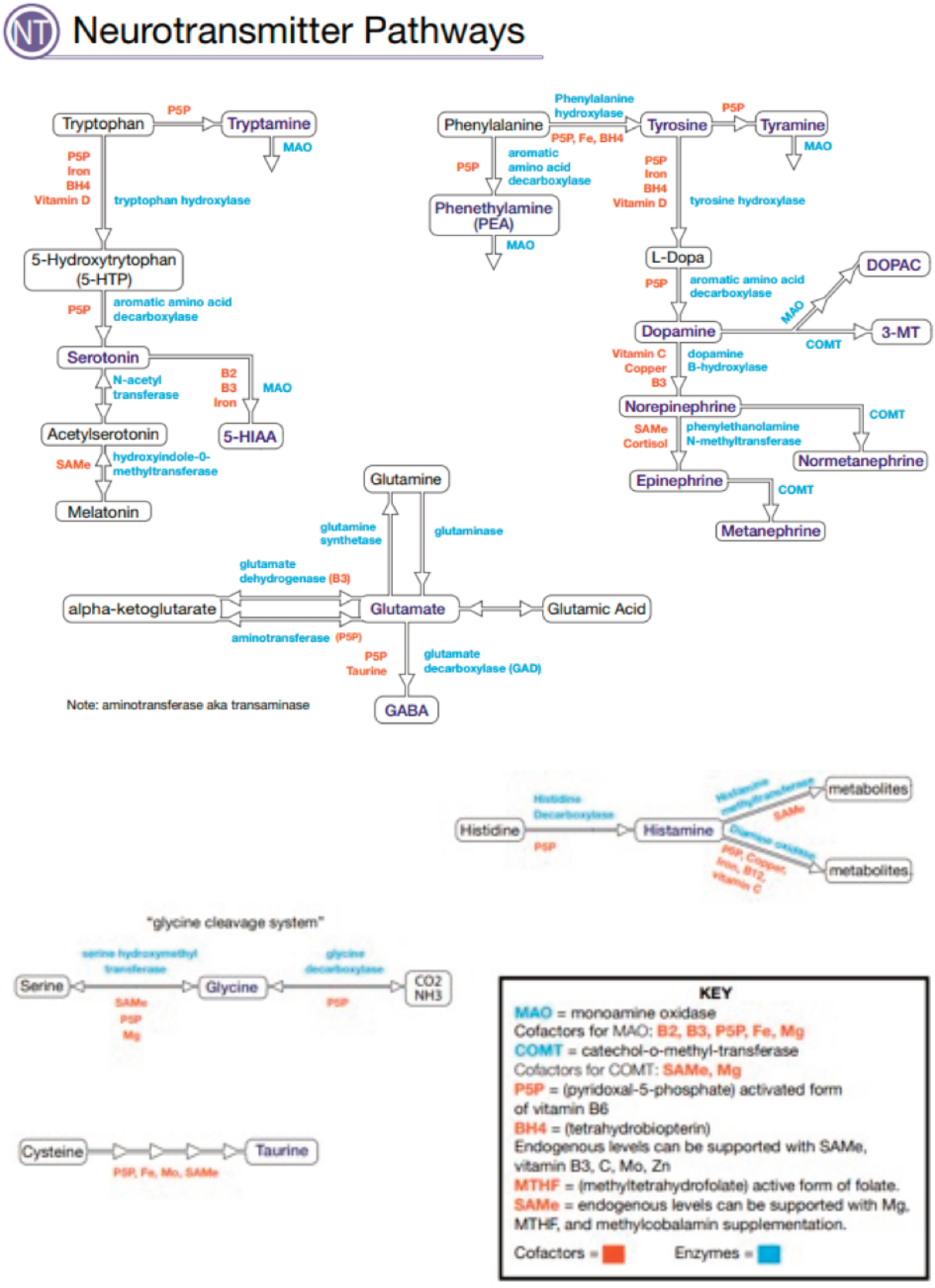
Current interventions for patients with mental health issues implement a best-guess strategy. Even if the mental health practitioner takes an extensive history of a patient, clinically correlates the patient's symptoms to known disorders, and makes proper recommendations based on pharmaceutical protocols, the patient may not feel better or recover. One study showed that only 24% recovered from major depressive disorder (MDD) without relapse in an 18-month period.[52] Another study concluded the percentages of remission [from MDD] for all patients randomly assigned to medication, psychotherapy, and control conditions were 46.4%, 46.3%, and 24.4%, respectively.[53]

The purpose of this case report is to demonstrate and propose that higher success rates can be achieved when testing urinary neurotransmitter metabolites in advance of intervention allowing for targeted nutraceutical or pharmaceutical intervention. Depression can be caused by an imbalance of serotonin, dopamine, or norepinephrine.[54] Because urinary assessments are non-invasive, with the added advantage of enhanced stability compared to cerebral spinal fluid or blood, the concept of neurotransmitter measurements as an objective means to assess nervous system function serves as a viable option for the clinician addressing neuropsychiatric health concerns.[15] The current body of literature provides evidence that neurotransmitters excreted in the urine may have a place in clinical practice as biomarkers of nervous system function.

TABLE 3: ANALYTE VS. INTERVENTION

Analyte vs. Intervention	Serotonin	Dopamine	NE/Epin	Glutamate	GABA	Glycine	Histamine	PEA	Creatinine
5-HTP 50-100 mg/day	X								
L-Theanine 400 mg/day	X	X	X	X	X				
Vit D 4000 iu/day or sunshine	X	X							
Multi vit w +Cu, Fe, Zn, Methylated B Complex (including B3, B6)	X	X	X	X			X		
Vit C 4-6 G/day		X							
Macuna Pruriens 50 mg/day		X	X						
L-Tyrosine 1200 mg/day		X	X						
Magnesium Malate 400 mg/day			X	X					
SAMe 400 mg/day			X				X		
Taurine 1 g/day				X					
Rhodiola 300 mg/day								X	
Exercise up to 1 hour/day	X	X							X

TABLE 4: NEUROTRANSMITTER PATHWAYS (DOCTOR'S DATA)



The primary limitation of this paper, as is with any case report, is that it only covers one patient, and only one illness, disordered eating. Future research should model this case report with other mental health disorders like depression, bipolarism, autism, ADHD, and schizophrenia. This case report highlights the benefits of testing urinary neurotransmitter metabolites prior to pharmaceutical or nutraceutical intervention with the aim of achieving positive results with the patient more efficiently.

This was a complex patient. As you can see, the majority of the supplements address more than one analyte. Her supplement recommendations included 10 total supplements, up to 11 supplements per day including vitamin D, if she was unable to get 15 minutes of sunshine per day. She was also told to exercise up to 1 hour per day to boost Serotonin and Dopamine, and less than 2-3 hours of exercise per day to raise the creatinine level.

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