

ENERGY CHEMISTRY: THE METABOLISM OF LIGHT

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In my previous commentary, I contrasted integrative medicine with mainstream medicine, which is unscientific in taking diagnosis as its main metaphor. Integrative medicine's main metaphor, balance, is more naturally bonded to the natural sciences and to everyday life, in which we recognize four features of balance:

1. *Multiple forces*: The notion of balance accommodates the interaction of multiple forces acting in a complex system, such as a living organism.
2. *Scalability*: The dynamics of balance are scalable, so that a system's balance can be slightly or substantially off-kilter and, in either instance, benefit from corrective measures.
3. *Collapse*: Failure of balance tends to be self-reinforcing and leads, at a certain threshold ("the tipping point"), to a state of collapse.
4. *Healing*: Restored balance can be maintained, thus giving rise to the notion of healing, toward which living systems have a strong tendency.

With the mainstream medical metaphor focusing on diagnosis, for example, Aidan, a child with fatigue, gastroesophageal reflux disease (GERD), difficulty attending, and hyperactive behavior gets a diagnosis of GERD and attention deficit with hyperactivity (ADHD). Once diagnosed, ADHD and GERD become the considered causes of his problems—according to the inane principle that the disease (an idea we form about groups of people with similar problems) can cause symptoms. The currently accepted treatment of Aidan's problems with amphetamines and H2 receptor blockers is a further logical muddle about whether studies carried out to show the safety and efficacy of drugs make them the right (ie, proven) treatment just because the

group taking them outperforms the placebo group. Such one-size-fits-all treatments are unscientific because they do not address the pathophysiologic causes of the symptoms. These treatments also do not address individuality, which give us many masks for the same underlying problems or one mask for different underlying problems.

An integrative-medicine approach to Aidan's problems would, at the very least, lead a practitioner to consider whether Aidan's biochemistry might be imbalanced because of an unmet individual need for essential nutrients (with, for example, magnesium and omega 3 oils high on the list), or that Aidan might be reacting to something to which he is sensitive, such a food, a toxin, or gut flora.

In my previous commentary, I listed 8 domains in physiology that provide us with a sense of order as we confront complexities in each patient's problem-solving. The first of these is energy, having to do with the biochemistry devoted to liberating the sun's forces from carbohydrates and lipids so that we can use those forces to produce energy. The rest of this commentary will focus on the laboratory and clinical aspects of looking at the metabolism of light.

Otto Wolff, a mentor who gave me the phrase, "metabolism of light" would cringe and howl when his students used the term "energy" loosely, preferring "forces" when speaking technically, and "energy"—if ever—when referring to fatigue or vitality. The vitalizing forces we associate with light enter us directly as sunlight. Even a sunbather, however, receives much more light in his or her food than in the sun's hot rays. Releasing the forces of light from food requires a balanced disassembly of the starches, sugars, and fats that are the bearers of light. Magnesium is the shepherd of light. It is present as the central atom in the chlorophyll molecule where the sun's light is gathered for producing

the sugars, starches, and fats from which we will eventually get our energy. At the other end of the system, magnesium is omnipresent in the catabolic steps in which we disassemble sugars and fats in our metabolic fire: the Krebs (citric acid) cycle.

No matter what the patient's diagnosis is, a clinician can begin her physiologic thinking with the first of 8 questions to be raised in this series of commentaries: "How is Aidan's fire burning?"

Some indirect clues to this question come from looking at Aidan. Does he glow? A healthy human should radiate light, or rather, reflect light so that there is an appearance we call the "glow of health," the opposite of which is a lackluster dullness to skin, hair, and eyes. If Aidan were a golden retriever, we would say he has a lackluster coat and would do well to have more fish in his diet.

Other clues come from his history, which reveals many symptoms from the magnesium indicators list¹ (Table 1). This list is better than any laboratory test at predicting response to magnesium supplementation.

An emissions test such as the test my automobile undergoes at the Motor Vehicle Department would help troubleshoot Aidan's energy chemistry. Aidan's diet is more complex than that of my car, which burns a refined fraction of very old vegetable oil called petroleum. Moreover, Aidan burns his energy sources at a relatively low temperature, compared to my car. Even so, Aidan's "exhaust" of metabolic by-products are similar to my car's exhaust in being acidic and mostly in the form of carbon dioxide and water. However, traces of heavier pollutants appear in his urine in the form of organic acids, the analysis of which provides a very useful emissions test on Aidan.

A urine organic-acid analysis profile and similar tests provided by various laboratories quantifying citric-acid cycle intermediaries, pyruvate, lactate, and various downstream products of intermediary metabolism, as well as insight into folate and B₁₂ function, give the clinician a good sense of options for intervening therapeutically to rebalance the system. The issue of rebalancing brings us back to the meaning of "balance" in the context of two questions about Aidan and his metabolic quirks, the first of which is: *Could he be failing to get something, which, if obtained, would upgrade his metabolic efficiency?* To the magnesium and omega-3 fatty acids mentioned above, I would add the whole list of about 50 essential minerals, vitamins, fatty acids and amino acids, as well as several accessory, nutritional factors, such as reduced glutathione, supplements of which can normalize elevated urinary levels of citric acid. Hormones such as adrenal and thyroid belong on

TABLE 1
MAGNESIUM INDICATORS LIST

Skeletal Muscle

- Muscle cramps, including back ache, neck pain, tension headache, temporomandibular joint dysfunction
- Muscle twitches and tics
- Muscle tension, sometimes resulting in adjustments that don't hold
- Muscle soreness
- Chest tightness or a peculiar "I can't seem to take a deep breath" or "I have to think about my breathing" that is often interpreted as hysterical. (In children, sighing may be a manifestation of this kind of chest tightness.)

Other Muscle

- Constipation
- Anal spasms, such as those that waken sleepers at night
- Urinary spasm
- Difficulty swallowing or "lump in my throat"
- Difficulty with adjusting to oncoming bright headlights because of spasms of the muscles that fine-tune pupillary diameter
- Cold hands and feet due to vasospasm
- Loud-noise sensitivity due to abnormal tension on the stapedius muscle
- Endometriosis due to "constipation" or reverse peristalsis of the uterus and Fallopian tubes
- Menstrual cramps
- Asthma / wheezing from constriction of bronchial muscles

Central Nervous System

- Insomnia
- Anxiety
- Hyperactivity and restlessness, constant movement
- Panic attacks
- Agoraphobia

Peripheral Nervous system

- Numbness
- Tingling
- Other abnormal sensations including "zips," "zaps," vibrations and other peculiar sensations

Cardiovascular

- Mitral valve prolapse
- Palpitations
- Arrhythmias
- Vasospastic angina
- Hypertension

Other

- Salt craving
- Carbohydrate craving
- Carbohydrate intolerance

the list with the question—if either would be the answer—as to why Aidan is not producing appropriate levels of either hormone. The other essential nurturing factors to consider are light—as in getting healthy exposure to full spectrum light and avoiding malillumination—and love, which should never be ignored in any consideration of human needs. Finally, rhythmic integration,² which will be the subject of a future commentary, may, when lacking, derail metabolic efficiency to the core of our functioning.

The second question about Aidan's needs is: *Could he be failing to avoid or rid himself of something that interferes with his metabolic efficiency?* All sorts of allergens and toxins belong on the complete list of possible offenders, but yeast problems come up more than any other as the culprit in disordered citric-acid cycle chemistry.

Here is an example of an effect I have observed often over the past 8 years since William Shaw first drew our attention to quantitative studies of urinary organic acids as markers of fungal dysbiosis.

Corey is an autistic child whose problems yielded dramatically to antifungal medications. One of the indicators that he might do well to correct a fungal dysbiosis was the finding of elevated urinary levels of substances that are not found in human metabolism, but are elaborated by fungi in the gut where they appear sequentially in the blood and urine. As is often the case in autistic children, abnormal urinary levels of fungal

metabolites were accompanied by levels of citric-acid cycle intermediaries consistent with some sort of inefficiency, and therefore representing “dirty exhaust” in my emissions-test analogy. Table 2 shows how the fungal metabolites and the citric-acid cycle intermediaries normalized with antifungal treatment.

A metabolic profile that measures downstream metabolites of fat, carbohydrate, neurotransmitter, and other metabolic pathways can be a very informative resource for judging metabolic efficiency, and can be the basis for prescribing various nutrients to enhance metabolic steps. The profile can also lead to strategies that detoxify substances that impair intermediary metabolism. In clinical practice, however, I regularly see metabolic profiles normalize after simply addressing a yeast problem.

Shaw has proposed a mechanism of molecular mimicry to explain how fungal metabolites may result in metabolic inefficiencies.³ Whatever the mechanisms, fungi are, after all, creatures of darkness and scavengers of light energy found in once-living things as they are returned to inorganic dust. It appears that fungal efficiency with the management of energy metabolism extends to having a keen capacity to interfere with that metabolism in fungal hosts and competitors.

SUMMARY

Integrative medicine offers, in its alternative to diagnostically-focused strategies, a way of approach-

TABLE 2
FUNGAL METABOLITES AND KREBS CYCLE INTERMEDIATES UNDER ANTIFUNGAL TREATMENT

| | Before Treatment | After Treatment | Reference Range |
|----------------------------------|------------------|-----------------|-----------------|
| Fungal Metabolites | | | |
| Citramalic acid | 2.69 | 1.34 | 0 – 2.00 |
| 5-hydroxy-methyl 2-furoic acid | 137 | 1.61 | 0 – 80 |
| 3-oxyglutaric acid | 1.36 | 0.11 | 0 – 0.50 |
| Tartaric acid | 75.44 | 1.27 | 0 – 16 |
| Krebs Cycle Intermediates | | | |
| Succinic acid | 43.11 | 14.8 | 0 – 20 |
| Aconitic acid | 39.6 | 18.4 | 0 – 25 |
| Citric acid | 2808 | 590 | 20–200 |

ing chronically ill individuals with an eye for balance. Investigation of balance with history, physical exam, and lab tests can be broken down into 8 areas of inquiry, one of which has to do with energy metabolism. Catabolism of fats and carbohydrates yields many avenues for considering supportive or interfering factors leading to treatment. My clinical experience suggests that problems in fatty-acid nutrition, magnesium deficiency, and fungal dysbiosis are frequent and easily addressed with laboratory testing and/or diagnostic therapeutic trials. Detoxification is the body's most energy-greedy process, and will be the

subject of my next commentary.

REFERENCES

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